ELECTRONIC COMPONENT FEEDER AND ELECTRONIC COMPONENT FEEDING METHOD

Technical Field

The present invention relates to an electronic component feeder and an electronic component feeding method for feeding a plurality of electronic components, arranged in alignment on a component feed tray, to mount the components onto a board.

Background Art

Conventionally, there have been known various structures of this kind of electronic component feeder. In such electronic component feeder, a plurality of pallets, on which component feed trays (hereinafter referred to as trays), often used as a feeding system for feeding electronic components to an electronic component mounting apparatus, are placed, are loaded stacked in layers (or stacked in tiers) in a magazine. The electronic component feeder, which employs such conventional magazine, is constructed so as to move up and down the magazine in a vertical direction, or a direction in which the pallets are stacked by use of an elevation unit, position one selected pallet in a pallet unloading position and unload this

pallet out of the magazine by use of a pallet unloader. Normally, such a tray unloading is performed by first collecting the pallet on which a used tray is placed by inserting the pallet into the magazine, next moving up or down the magazine by an elevation unit to place this selected one pallet in an unloading position, i.e., a position at a same height level as that of the pallet unloader, and then drawing this selected pallet out of the magazine. Subsequently, performed is picking up (e.g., picking up by suction) each of electronic components in the tray placed on the pallet unloaded from the magazine by use of a transfer head or the like of the electronic component mounting apparatus.

Moreover, when the electronic components in the tray have been picked up and depleted or in a similar case, the pallet, on which an emptied tray is placed, is replaced by a pallet on which a new tray is placed. However, the above-mentioned pallet replacing work is performed by an operator's hand, when the operator sometimes sets (loads) the pallet reversely in a lengthwise direction by mistake into the magazine. Since the pallet does not generally have a structure symmetrical in the lengthwise direction, this reversely set pallet cannot produce its function, and this leads to a problem in that the electronic component feeder cannot be correctly operated, thereby possibly

causing damage of constituent components of the feeder as well as scattering and damage of the electronic components and so on arranged on the tray.

There has conventionally been developed an electronic component feeder, which can prevent stoppage of the electronic component feeder and damage of the constituent components of the feeder due to erroneous setting in the lengthwise direction of the pallet into the magazine.

For example, there is a conventional electronic component feeder, in which configurations of an edge portion located on a forward side and an edge portion located on a rearward side of each pallet are made different from each other, and an engagement member having a configuration that engages with this forward-side edge portion and does not engage with this rearward-side edge portion is arranged on a forward side of the magazine (refer to, for example, Japanese unexamined Patent Publication 11-121985 A). According to construction of such conventional electronic component feeder, erroneous setting of loading a pallet reversely in the lengthwise direction in the magazine can be prevented by the engagement member.

However, the aforementioned structure has a problem in that, although the pallet can be prevented from

being loaded reversely in the lengthwise direction, when the pallet is loaded correctly in the lengthwise direction even if the pallet is loaded inclined in the magazine, such erroneous setting cannot be detected (or prevented).

Particularly, with an increasing degree of unfamiliarity with work due to shifting of operators themselves and an increasing frequency of replacement of pallets in the magazine by the operators as a consequence of an increasing electronic component mounting speed and ongoing diversified small-lot production, there is an increasing number of cases of erroneous reverse setting in the lengthwise direction and such erroneous inclined setting. Particularly, it is required to insert the pallet (or the magazine itself) while confirming the state of the electronic components, and therefore, an operator naturally turns his or her gaze downward upon the pallet from above (e.g., a positional relationship between the operator and the pallet is shown in Fig. 2). In such a situation, the operator, who is concentrating his or her attention on the electronic components, is hardly aware of inclined pallet insertion. Moreover, there is a problem in that possibility of occurrence of erroneous inclined pallet setting by the operators has been increased because of an increasing number of trays to be loaded into the magazine, i.e., an increasing number of pallets in accordance with

reductions in size and thickness of electronic components to be mounted, and further with diversification of types of the electronic components.

Moreover, in actual circumstances of recent growing demands for high-speed and high-efficiency mounting of electronic components, operation stoppage of the electronic component feeder due to erroneous pallet setting is one of factors of hindering achievement of the high speed and high efficiency. Also, for achievement of the high-speed and high-efficiency mounting of electronic components, it is demanded to make detectable any erroneous pallet setting in the magazine.

Moreover, there are known various methods for performing suction and pickup (i.e., the aforementioned pickup) of each electronic component by sucking and holding each electronic component, by use of a suction nozzle provided for a transfer head, a mounting head or the like, from a tray fed by such conventional electronic component feeder (refer to, for example, Japanese unexamined Patent Publication 10-335889 A), and one example will be described with reference to the drawings.

First of all, Fig. 24 shows a schematic plan view of a component feed tray 552 as one example of a tray in which electronic components 551 of such plurality of electronic components are arranged in alignment for

explanation. As shown in Fig. 24, the component feed tray 552, which has a roughly plate-like configuration, is arranged on a tray placement surface 554 that is an upper surface of a tray plate 553 (corresponding to the pallet) that similarly has a roughly plate-like configuration.

Moreover, the component feed tray 552 has a component arrangement region 555 on its upper surface, and the electronic components 551 are arranged in alignment in this component arrangement region 555. Moreover, the component feed tray 552 is arranged at, for example, a lower left-hand corner of the tray placement surface 554 in Fig. 24 and arranged on the tray placement surface 554 with two fixation bars 556 brought into contact with respective edge portions of the component feed tray 552. With this arrangement, arrangement of the component feed tray 552 is fixed in directions along the tray placement surface 554.

In this case, Fig. 25 shows a schematic sectional view showing a cross-sectional structure of this fixation bar 556. As shown in Fig. 25, the fixation bar 556 is a rod-shaped member, which has a roughly C-figured cross section and includes a fixation bar main body 556a that fixes an arrangement position of the component feed tray 552 by being brought into contact with an end portion of the component feed tray 552, and a magnet section 556b fixed inside the C-figured cross section of this fixation

bar main body 556a. Moreover, the fixation bar main body 556a can be magnetically releasably connected to the tray placement surface 554 of the tray plate 553 via this magnet section 556b.

Moreover, an end portion of the fixation bar main body 556a brought into contact with the end portion of the component feed tray 552 has an end surface configuration formed roughly perpendicular to the tray placement surface 554. Therefore, as shown in Fig. 25, the fixation bar 556 magnetically fixed on the tray placement surface 554 via the magnet section 556b comes into contact with an end portion of the component feed tray 552, by which the arrangement position of the component feed tray 552 can be fixed in a direction that extends along the tray placement surface 554 and roughly perpendicular to a direction in which the fixation bar 556 extends.

Moreover, as shown in Fig. 24, by using two fixation bars 556 described above, the arrangement position of the component feed tray 552 can be fixed in mutually perpendicular directions along the tray placement surface 554. As shown in Fig. 24, peripheral portions 557 of the tray plate 553 are formed protuberant above the tray placement surface 554, and two other sides in which the two fixation bars 556 are not in contact at the component feed tray 552 are brought into contact with the peripheral

portions 557 of the tray plate 553. With this arrangement, the arrangement position is fixed in the aforementioned directions in which four sides of the component feed tray 552 are surrounded by the peripheral portions 557 of the tray plate 553 and the two fixation bars 556.

Moreover, this conventional fixation bar 556 described above is not limited to one that is provided with the magnet section 556b and magnetically fixed on the tray placement surface 554, and fixation bars 556 of various forms are used. For example, as shown in Fig. 26, there is also used a conventional fixation bar 566 having a form such that a rod-shaped fixation bar main body 566a having a roughly L-figured cross-sectional shape is fixed on the tray placement surface 554 by a fastening screw 566b. Even in a case of the fixation bar 566 described above, an end surface configuration of an end portion to be brought into contact with the end portion of the component feed tray 552 is formed roughly perpendicular to the tray placement surface 554.

However, in the above-mentioned structure, although the arrangement position of the component feed tray 552 is fixed on the tray placement surface 554 of the tray plate 553, fixation is only effected in directions along the tray placement surface 554. Therefore, in a case where a suction nozzle disadvantageously sucks and holds,

for example, a portion where the electronic component 551 is not arranged on the component feed tray 552, when the electronic components 551 arranged on the component feed tray 552 are each sucked and held and picked up by a suction nozzle, there is a problem in that the component feed tray 552 itself is disadvantageously uplifted from the tray placement surface 554 in accordance with ascent of the suction nozzle, thereby possibly causing displacements in arrangement positions of other electronic components 551 arranged on the component feed tray 552 and leap-up of the electronic components 551 from the component feed tray 552.

Occurrence of such a problem becomes significant particularly when electronic components 551 that tend to be reduced in thickness in recent years are picked up by suction and holding. That is, a difference in a height position between a height position of a suction and holding surface of electronic component 551 reduced in thickness, and a height position of an arrangement surface of the electronic component 551 on the component feed tray 552, is reduced in accordance with this reduction in the thickness of the electronic component 551. Accordingly, there are problems of high possibility of occurrence of disadvantageous suction of the component feed tray 552 by a suction force of a suction nozzle when there is no electronic component 551 existing in the height position

where the electronic component 551 is sucked and held by a lowered suction nozzle, and high possibility of consequent occurrence of uplift of the component feed tray 552 and so on.

Moreover, occurrence of erroneous suction of the component feed tray 552 by the suction nozzle as described above is sometimes caused by erroneous input of component data or the like of the electronic components 551 to a control unit that executes motion control of the suction nozzle.

As described above, there is a problem in that efficient electronic component feeding cannot be achieved when leap-up or the like of electronic components 551 is caused by erroneous suction of the component feed tray by the suction nozzle, and this significantly lowers a rate of operation of an electronic component mounting apparatus provided with the suction nozzle, thereby failing in performing efficient component mounting.

Summary Of The Invention

Accordingly, an object of the present invention is to solve the aforementioned problems and provide an electronic component feeder and electronic component feeding method capable of performing efficient electronic component feeding by achieving a smooth and reliable

feeding operation in electronic component feeding for feeding a plurality of electronic components arranged in alignment on a component feed tray for mounting of the components onto a board.

In concrete, by reliably easily detecting presence or absence of an abnormality in a pallet support posture in a magazine and preventing stoppage of an electronic component feeder operation and damage of constituent components of the feeder attributed to the abnormality in the support posture in the electronic component feeder that feeds the plurality of electronic components arranged in alignment on the component feed tray to an electronic component mounting apparatus, an electronic component feeder capable of achieving efficient feeding of electronic components is provided.

Furthermore, there is provided an electronic component feeder and electronic component feeding method capable of achieving the aforementioned efficient feeding of the electronic components by preventing leap-up of components caused by erroneous suction of the component feed tray by a component suction and holding member beforehand at a time of component pickup performed by sucking and holding the components from the component feed tray arranged allowing the plurality of electronic components to be picked up by the component suction and

holding member.

In accomplishing these and other aspects, according to a first aspect of the present invention, there is provided an electronic component feeder for loading a plurality of pallets, on each of which component feed trays for carrying a plurality of electronic components arranged in alignment are placed, in a plurality of stacked tiers, and for feeding the electronic components on a component feed tray placed on a pallet unloaded from among these loaded pallets to an electronic component feed position along a pallet feed direction, the feeder comprising:

a magazine, in which a plurality of pairs of support sections for supporting mutually opposed edge portions of the pallets in a direction perpendicular to the pallet feed direction, so that the pallets are supported roughly horizontally and movably in the pallet feed direction, are formed at regular intervals in a stacking direction, for loading the pallets supported by corresponding pairs of support sections;

a magazine receiver for receiving the magazine elevatably, which has a pallet feed port for allowing the pallets loaded in the magazine to be unloaded from inside the magazine to an electronic component feed position;

a magazine elevation unit for driving elevation of the magazine inside the magazine receiver while allowing

a selected pallet to be unloaded through the pallet feed port;

a forward-side regulating member for regulating support positions of the pallets loaded in the magazine by the corresponding support sections by being brought into contact with an edge portion of the pallet on a forward side in the pallet feed direction;

a rearward-side regulating member, movable in the pallet feed direction, for regulating support positions of the pallets, regulated by the forward-side regulating member by the corresponding support sections, by being brought into contact with an edge portion of the pallets on a rearward side in the pallet feed direction; and

a horizontal posture regulating member, which is provided integrally with the magazine, for regulating a roughly horizontal support posture of the pallets so that a support posture of each of the pallets, whose edge portions are supported by the corresponding pairs of support sections, by being arranged between the pallets stacked in tiers in the magazine,

with the pallets being formed so that configurations of a forward-side edge portion and a rearward-side edge portion in the pallet feed direction are formed differently, with the feeder being able to detect inclusion of a pallet supported in a reversely directed

support posture in the pallet feed direction in the magazine on basis of a regulation position of the pallet by the rearward-side regulating member, and with the feeder being able to detect inclusion of a pallet in a support posture supported by support sections that are not mutually opposed in the magazine by use of the horizontal position regulating member.

According to a second aspect of the present invention, there is provided the electronic component feeder according to the first aspect, wherein

the magazine is provided with a magazine door section which is an openable door provided on a rearward side in the pallet feed direction for feeding and loading the pallets from the rearward side, and on an inside of which the rearward-side regulating member and the horizontal posture regulating member are fixed,

wherein the rearward-side regulating member can limit closing of the magazine door section by being brought into contact with an edge portion of a pallet supported in a reversely directed support posture, and the magazine door section can be closed in a position where the rearward-side regulating member is brought into contact with an edge portion of a pallet supported in a forwardly directed support posture in the pallet feed direction,

wherein the horizontal posture regulating member

can limit closing of the magazine door section by being brought into contact with an edge portion of the pallet supported by the support sections that are not mutually opposed, and the magazine door section can be closed by inserting the horizontal posture regulating member between the pallets supported by the pair of support sections, and

wherein inclusion of a pallet, that has an abnormality in its support posture, in the magazine can be detected by limitation of the closing of the magazine door section.

According to a third aspect of the present invention, there is provided the electronic component feeder according to the second aspect, further comprising:

a door opening/closing detector for detecting an open state or a closed state of the magazine door section; and

a door opening and closing display section for displaying a detection result by the door opening/closing detector while allowing an operator to recognize the result.

According to a fourth aspect of the present invention, there is provided the electronic component feeder according to the third aspect, wherein

the magazine receiver has a receiver door section that is an openable door provided on a rearward side in the pallet feed direction, for being closed in a state in which

its inside is brought into contact with an outside of the magazine door section in a closed state, for being limited in its closing by being brought into contact with the outside of the magazine door section to limit the closing.

According to a fifth aspect of the present invention, there is provided the electronic component feeder according to the fourth aspect, wherein the door opening/closing detector is provided for the receiver door section.

According to a sixth aspect of the present invention, there is provided the electronic component feeder according to the third aspect, further comprising a control unit for stopping a driving operation of the magazine elevation unit when the open state of the magazine door section is detected by the door opening/closing detector.

According to a seventh aspect of the present invention, there is provided the electronic component feeder according to the second aspect, wherein the horizontal posture regulating member is provided with a plurality of projections which are formed arranged in a stacking direction at the same intervals as intervals of the support sections, for being inserted into gaps between the pallets supported by the pair of support sections, for being limited to be inserted into the gaps by being brought

into contact with the edge portion of pallets supported by the support sections that are not mutually opposed.

According to an eighth aspect of the present invention, there is provided the electronic component feeder according to the seventh aspect, wherein the horizontal posture regulating member is fixed on the magazine door section so that the projections are arranged in positions located closer to either one of the support sections away from a possible intermediate position between the mutually opposed support sections in a state in which the magazine door section is closed.

According to a ninth aspect of the present invention, there is provided the electronic component feeder according to the eighth aspect, wherein the projections are arranged so that any of the projections interferes with a pallet supported by the support sections which includes another support section displaced by at least one step in a stacking direction with respect to the support section opposed to one support section.

According to a tenth aspect of the present invention, there is provided the electronic component feeder according to the first aspect, wherein

each of the pallets has a pallet unloading grip portion, which has a roughly rectangular shape and is formed roughly in a protruding configuration at an edge

portion located on a forward side in the pallet feed direction, and

the rearward-side regulating member is arranged so as to be able to come into contact with the grip portion of a pallet supported in a reversely directed support posture by the support sections.

According to an eleventh aspect of the present invention, there is provided the electronic component feeder according to the seventh aspect, wherein the projections of the horizontal posture regulating member have a length dimension such that the projections do not reach a place above an arrangement region of the electronic components on the component feed tray placed on each of the pallets in a state in which the projections are inserted in gaps between the pallets.

According to a twelfth aspect of the present invention, there is provided the electronic component feeder according to the first aspect, wherein

the feeder further comprises a component feed tray fixation bar for fixing the component feed tray releasably on a placement surface of the pallet,

with the fixation bar comprising:

a first direction fixation portion, for releasably fixing its arrangement position on the placement surface, for releasably fixing a placement position of the

component feed tray in a first direction, that is a direction along the placement surface, by being brought into contact with the component feed tray placed on the placement surface; and

a second direction fixation portion, for releasably fixing its arrangement position on the placement surface, for releasably fixing a placement position in a second direction, that is a direction roughly perpendicular to the placement surface, by being brought into contact with the component feed tray.

According to a thirteenth aspect of the present invention, there is provided the electronic component feeder according to the twelfth aspect, wherein, with regard to the component feed tray fixation bar,

the first direction fixation portion is a first direction fixation surface, formed roughly perpendicular to the placement position, where the placement position is fixed in the first direction by this surface being brought into contact with an end portion of the component feed tray, and

the second direction fixation portion is a second direction fixation surface, formed roughly perpendicular to the placement position, where the placement position is fixed in the second direction by this surface being brought into contact with an end portion of the component feed tray.

According to a fourteenth aspect of the present invention, there is provided the electronic component feeder according to the thirteenth aspect, wherein, with regard to the component feed tray fixation bar,

a height position of the second direction fixation surface brought into contact with the edge portion of the component feed tray is adjustable in the second direction.

According to a fifteenth aspect of the present invention, there is provided the electronic component feeder according to the twelfth aspect, wherein, with regard to the component feed tray fixation bar,

the fixation bar is provided with an urging member that always urges the second direction fixation portion toward an end portion of the component feed tray.

According to a sixteenth aspect of the present invention, there is provided the electronic component feeder according to the thirteenth aspect, wherein, with regard to the component feed tray fixation bar,

the fixation bar comprises:

a plurality of second direction fixation surfaces formed at different height levels; and

a plurality of first direction fixation surfaces individually corresponding to the second direction fixation surfaces, and

the placement position of the component feed tray is fixed by the second direction fixation surface, that conforms to a height of an end portion of the component feed tray and belongs to the second direction fixation surfaces, and the first direction fixation surface that corresponds to the second direction fixation surface.

According to a seventeenth aspect of the present invention, there is provided the electronic component feeder according to the twelfth aspect, wherein, with regard to the component feed tray fixation bar,

the first direction fixation portion is a first direction fixation surface for fixing the placement position in the first direction by being brought into contact with an end portion of the component feed tray,

the second direction fixation portion is a second direction fixation surface for fixing the placement position in the second direction by being brought into contact with an end portion of the component feed tray, and

the first direction fixation surface and the second direction fixation surface serve as an identical fixation surfaces formed inclined with respect to the placement surface.

According to an eighteenth aspect of the present invention, there is provided the electronic component feeder according to the twelfth aspect, wherein, with

regard to the component feed tray fixation bar,

the fixation bar comprises a magnetic member, formed of a magnetic material on or near its arrangement surface on the placement surface, for being fixed on the placement surface by a magnetic force of the magnetic member.

According to a nineteenth aspect of the present invention, there is provided an electronic component feeding method for feeding a plurality of electronic components to be mounted on a board by performing suction and holding and pickup of the electronic components from a component feed tray, in which the electronic components are arranged while being able to be sucked and picked up by a component suction and holding member capable of sucking and holding each of the components with suction pressure,

with the component suction and holding member performing the suction and holding and pickup of each of the electronic components with a component holding and suction pressure which is a suction pressure that is not lower than a suction pressure capable of sucking and holding the electronic component and lower than a suction pressure capable of sucking and holding the component feed tray.

According to a twentieth aspect of the present invention, there is provided the electronic component

feeding method according to the nineteenth aspect, including:

bringing the component suction and holding member into contact with the electronic component by lowering the component suction and holding member after aligning in position the component feed tray with the component suction and holding member;

starting suction by the component suction and holding member so that the suction pressure reaches the component holding and suction pressure when the component suction and holding member, brought into contact with the electronic component, starts ascending; and

performing the suction and holding and pickup of the electronic component with ascent of the component suction and holding member.

According to a twenty-first aspect of the present invention, there is provided the electronic component feeding method according to the twentieth aspect, wherein a timing of starting the suction is determined in consideration of a time for which the suction pressure reaches the component holding and suction pressure from start of the suction by the component suction and holding member.

According to a twenty-second aspect of the present invention, there is provided the electronic

component feeding method according to the twentieth aspect, including starting the suction by the component suction and holding member after the component suction and holding member is brought into contact with the electronic component.

According to a twenty-third aspect of the present invention, there is provided the electronic component feeding method according to the twentieth aspect, wherein a time for lowering the component suction and holding member is determined according to a size or a weight of the electronic component so as to prevent leap-up of the electronic component from the component feed tray due to the component suction and holding member being brought into contact with the electronic component.

According to a twenty-fourth aspect of the present invention, there is provided the electronic component feeding method according to any one of the nineteenth aspect through the twenty-third aspect, wherein the component holding and suction pressure is a suction pressure determined according to a size or a weight of the electronic component.

According to the first aspect of the present invention, the electronic component feeder is provided with the forward-side regulating member that regulates the support position of the pallets loaded in the magazine by

the respective support sections by being brought into contact with the edge portions of the pallets on the forward side in the pallet feed direction, and the rearward-side regulating member that is movable along the pallet feed direction and regulates the pallets regulated by the forward-side regulating member by being brought into contact with the edge portions of the pallets on the rearward side in the pallet feed direction. With this arrangement, when the pallets, which are formed so that an edge configuration on the forward side and an edge configuration on the rearward side are different from each other, are loaded in the magazine, it can be detected that a pallet loaded in a reversely directed support posture is included among the loaded pallets on basis of a difference in a contact position by the rearward-side regulating member.

Furthermore, with provision of the horizontal posture regulation member, which can be arranged between the pallets loaded in the magazine and regulates a roughly horizontal pallet support posture so as to maintain the support posture by virtue of the above-mentioned arrangement, by arranging the horizontal posture regulation member in the gaps between the pallets, the pallets can be loaded in the magazine without being inclined and with the roughly horizontal support posture maintained. Furthermore,

when the horizontal posture regulating member cannot be arranged in the gaps due to contact and consequent interference of the horizontal posture regulation member with any of the pallets, it can be detected that there is included a pallet in an inclined support posture.

Therefore, an abnormality in a support posture of a pallet loaded in the magazine can be detected reliably and easily in the electronic component feeder, and pallets can consistently be loaded in a correct support posture. Therefore, occurrence of an operation stop of the electronic component mounting apparatus and damage or the like of the constituent components of the electronic component feeder attributed to the aforementioned pallet support posture can be prevented.

According to the second aspect of the present invention, the magazine door section is provided with the rearward-side regulating member and the horizontal posture regulating member, and closing of the magazine door section is limited in the aforementioned position where the rearward-side regulating member is brought into contact with the edge portion of the pallet supported in a reversely directed support posture. Moreover, by a limitation of the closing of the magazine door section due to the horizontal posture regulating member being brought into contact with the edge portion of the pallet supported

by the support sections that are not mutually opposed, it can reliably be detected that a pallet having an abnormality in its support posture is included among the pallets loaded in the magazine. Moreover, since the above-mentioned detection can be performed only by opening or closing the magazine door section, it is possible to perform the detection more easily and recognizably to the operator.

According to the third aspect of the present invention, it is possible to reliably detect opening/closing of the magazine door section and reliably make the operator recognize a result by the door opening/closing detection section capable of detecting an open state or a closed state of the magazine door section and the door opening/closing display section that displays a detection result of the door opening/closing detection section recognizably to the operator.

According to another aspect of the present invention, it is possible to regard the opening/closing of the receiver door section, which is opened and closed in accordance with the opening and closing of the magazine door section, as the opening/closing of the magazine door section and to provide the receiver door section with the door opening/closing detection section.

Moreover, by stopping driving by the magazine

elevation unit when the open state of the magazine door section is detected by the door opening/closing detection section, occurrence of damage or the like of constituent components of the feeder attributed to an abnormality in the pallet support posture can be prevented beforehand.

Moreover, the horizontal posture regulating member is provided with the plurality of projections to be inserted in the gaps between the pallets. With this arrangement, any projection among the projections interferes with any of the pallets, thereby making it possible to reliably easily detect that a pallet in an inclined support posture is loaded in the magazine.

Moreover, the projections of the horizontal posture regulating member are arranged avoiding a position intermediate the mutually opposed support sections. With this arrangement, a pallet in the inclined support posture and any of the projections can reliably be made to interfere with each other, thereby allowing an abnormality in the pallet support posture to be reliably detected.

Moreover, the projections are arranged so that any of the projections interferes with the pallet supported by the support sections of which the other support section is displaced by at least one step in the stacking direction with respect to the support section opposed to one support section. With this arrangement, a support posture

displaced by one step, which tends to be rather neglected by the operator, can reliably be detected.

Moreover, pallets having a roughly rectangular shape have a grip portion, which is to unload a corresponding pallet and is formed roughly in a protruding configuration at an edge portion located on the forward side in the pallet feed direction, are employed in the magazine, and the rearward-side regulating member is arranged so as to be able to come into contact with the grip portion of the pallet supported in a reversely directed support posture by the support sections. With this arrangement, a forwardly directed support posture and a reversely directed support posture of the pallet can reliably be distinguished and detected by a difference in a position where the pallet is brought into contact with the rearward-side regulating member.

Moreover, the projections of the horizontal posture regulating member are formed with a dimension in length such that the projections do not reach a place above a region where the electronic components are arranged on the tray placed on each of the pallets in a state in which the projections are inserted in the gaps between the pallets. This arrangement is able to reliably prevent interference between the electronic components, arranged in alignment in an arrangement region, and the projections,

and reliably prevent occurrence of damage of the electronic components.

According to the twelfth aspect of the present invention, the component feed tray fixation bar, which releasably fixes the component feed tray on the pallet placement surface in the electronic component feeder, is provided with not only the first direction fixation portion that fixes the placement position of the component feed tray in the first direction, or the direction along the placement surface, but also the second direction fixation portion that fixes the placement position of the component feed tray in the second direction roughly perpendicular to the placement surface. With this arrangement, the component feed tray can be fixed in the first direction and the second direction.

If, for example, in a case where the component feed tray itself is sucked and held (so-called erroneous suction) by the component suction and holding member in sucking and holding the component arranged on a thus fixed component feed tray by use of the component suction and holding member occurs, the component feed tray is fixed also in the second direction, and therefore, occurrence of uplift of the component feed tray can be prevented beforehand. Accordingly, there can be provided a component feed tray fixation bar capable of preventing occurrence of

leap-up, displacement in the arrangement position and so on of the components due to occurrence of the erroneous suction of the component feed tray during component mounting, and contributing to achievement of efficient component feeding.

Moreover, according to another aspect of the present invention, the first direction fixation portion is the surface (first direction fixation surface) arranged roughly perpendicular to the placement surface, and the second direction fixation portion is the surface (second direction fixation surface) arranged along the placement surface. With this arrangement, by bringing the surfaces in contact (e.g., contact causing surface contact) with the end portions of the component feed tray, the component feed tray can be fixed in the first direction and the second direction.

Moreover, a height position of contact with the end portion of the component feed tray on the second direction fixation surface is adjustable in the second direction. This arrangement can cope with fixation of component feed trays that have a variety of configurations and allows the fixation to be reliably achieved.

Moreover, the fixation bar is provided with an urging member that consistently urges the second direction fixation portion toward the end portion of the component

feed tray along the second direction. With this arrangement, a force of fixation in the second direction can be further improved, thereby allowing more reliable fixation to be achieved. Furthermore, an increased force of fixation can reliably resist a force that tries to uplift the component feed tray due to erroneous suction of the component feed tray by a component suction and holding member.

Moreover, with the plurality of first direction fixation surfaces and second direction fixation surfaces formed individually in correspondence, the component feed tray can be fixed by selecting a combination of the fixation surfaces corresponding to a configuration (e.g., an end portion formation height and so on) of the component feed tray to be fixed. This arrangement can therefore cope with fixation of component feed trays that have further diversified configurations.

Moreover, the first direction fixation surface and the second direction fixation surface are identical fixation surfaces formed inclined with respect to the placement surface. With this arrangement, the component feed tray can concurrently be fixed in the first direction and the second direction by identical fixation surfaces. Therefore, a configuration of the fixation bar can be simplified, and production workability can be made

satisfactory. Furthermore, fixation is effected by bringing the inclined fixation surface into contact with the end portion of the component feed tray. Therefore, it becomes possible to achieve the above-mentioned contact without being influenced by a formation height of the end portion, and this can cope with fixation of component feed trays that have diversified forms.

Moreover, since the fixation bar is provided with the magnetic member, the fixation bar can be fixed in a desired position of the placement surface by a magnetic force of the magnetic member. This allows handlability of the fixation bar to be satisfactory and reliable fixation to be achieved regardless of a configuration of the component feed tray to be fixed.

According to the nineteenth aspect of the present invention, by the electronic component feeding method for feeding electronic components from the component feed tray to a board by use of the component suction and holding member, even when erroneous suction of the component feed tray by the component suction and holding member occurs by performing suction and holding and pickup of an electronic component with a component holding and suction pressure of a suction pressure that is not lower than the suction pressure capable of sucking and holding the electronic component and lower than the suction pressure capable of

sucking and holding the component feed tray, an erroneously sucked component feed tray is not uplifted with lifting of the component suction and holding member, and occurrence of leap-up of the electronic components and so on caused by occurrence of such uplift can be prevented beforehand. Therefore, an electronic component feeding method capable of performing reliable component pickup and contributing to achievement of efficient component mounting can be provided.

Moreover, according to another aspect of the present invention, by starting the suction by the component suction and holding member so that the suction pressure reaches the component holding and suction pressure when lifting of the component suction and holding member, brought into contact with the electronic component, is started, the suction can be started with reference to a time point of an operation at which the component suction and holding suction pressure is needed, and a time zone in which a needless suction pressure is generated can be shortened. As a result, possibility of occurrence of some influences (e.g., occurrence of displacement caused by suction of neighboring components and occurrence of erroneous suction of the component feed tray itself) on peripheries of the component suction and holding member due to generation of the suction pressure can be reduced. Moreover, it is possible to promote energy saving by a

reduction in a suction pressure application time.

Moreover, a suction start timing is determined in consideration of an amount of time needed from the start of suction by the component suction and holding member to a time when the suction pressure reaches the component holding and suction pressure. This makes it possible to reliably generate the component holding and suction pressure at the time of starting the lifting of the component suction and holding member and to perform reliable suction and holding.

Moreover, a suction start by the component suction and holding member is performed after the component suction and holding member is brought into contact with the component. This makes it possible to reliably suck and hold only an electronic component brought into contact by generated suction pressure and to reliably prevent occurrence of erroneous suction of the component feed tray.

Moreover, a time needed for lowering the component suction and holding member is determined in accordance with a size or weight of a component so as to prevent leap-up of the electronic component from the component feed tray due to the component suction and holding member being brought into contact with the electronic component, and the component holding and suction pressure is a suction pressure determined in accordance

with a size or weight of the component. This arrangement can cope with suction and holding of a variety of types of electronic components.

Brief Description of Drawings

These and other aspects and features of the present invention will become clear from the following description taken in conjunction with the preferred embodiments thereof with reference to the accompanying drawings, in which:

Fig. 1 is an external perspective view of an electronic component mounting apparatus provided with an electronic component feeder according to a first embodiment of the present invention;

Fig. 2 is a schematic cross-sectional view showing a schematic structure of the electronic component feeder of Fig. 1;

Fig. 3 is a schematic perspective view of a tray and a pallet handled by the electronic component feeder;

Fig. 4 is a schematic sectional view (showing a normal loading state of pallets) of a cross section perpendicular to a pallet feed direction of a magazine;

Fig. 5 is a cross-sectional view taken along line B-B (showing the normal loading state of the pallets) of the electronic component feeder of Fig. 2;

Fig. 6 is a sectional view showing a state in which an outer door and an inner door are opened at the electronic component feeder of Fig. 5;

Figs. 7A and 7B are schematic sectional views of a large-size magazine in a direction perpendicular to a pallet feed direction, showing a state in which a pallet in an inclined support posture is included, wherein Fig. 7A shows a state in which the pallet is supported by rack portions shifted by two steps, and Fig. 7B shows a state in which the pallet is supported by rack portions shifted by one step;

Figs. 8A and 8B are schematic sectional views of a small-size magazine in a direction perpendicular to the pallet feed direction, showing a state in which a pallet in an inclined support posture is included, wherein Fig. 8A shows a state in which the pallet is supported by rack portions shifted by two steps, and Fig. 8B shows a state in which the pallet is supported by rack portions shifted by one step;

Fig. 9 is a view corresponding to a sectional view of the electronic component feeder of Fig. 4, showing a state in which a pallet is loaded in a reversely directed support posture;

Fig. 10 is a view corresponding to a sectional view of the electronic component feeder of Fig. 4, showing

a state in which a pallet is loaded in an inclined support posture;

Fig. 11 is a schematic partial sectional view of a cross section of a small-size magazine in a direction perpendicular to the pallet feed direction;

Fig. 12 is a schematic partial sectional view of a cross section of a large-size magazine in the direction perpendicular to a pallet feed direction;

Figs. 13A and 13B are schematic views of a tray plate provided with fixation bars used in an electronic component feeder according to a second embodiment of the present invention, wherein Fig. 13A shows a plan view, and Fig. 13B shows a side view;

Figs. 14A and 14B are schematic views of a state in which a component feed tray is fixed on the tray plate of Figs. 13A and 13B by use of fixation bars, wherein Fig. 14A shows a plan view, and Fig. 14B shows a side view;

Fig. 15 is a schematic sectional view of the fixation bar of Figs. 13A and 13B;

Fig. 16 is a schematic explanatory view showing a force generated when an attractive force is imposed on the component feed tray fixed by the fixation bar of Figs. 13A and 13B;

Fig. 17 is a sectional view of a fixation bar according to a first modification example of the fixation

bar of Fig. 15;

Fig. 18 is a sectional view of a fixation bar according to a second modification example of the fixation bar of Fig. 15;

Fig. 19 is a sectional view of a fixation bar according to a third modification example of the fixation bar of Fig. 15;

Figs. 20A and 20B are schematic views of a tray plate according to a modification example of the tray plate of Figs. 13A and 13B, wherein Fig. 20A shows a plan view, and Fig. 20B shows a side view;

Figs. 21A, 21B and 21C are operation timing charts of an electronic component feeding method according to a third embodiment of the present invention, wherein Fig. 21A shows suction valve operation timing, Fig. 21B shows a state of a suction pressure change, and Fig. 21C shows an elevation height position of the suction nozzle;

Fig. 22 is a schematic side view of a component mounting head of the third embodiment;

Figs. 23A, 23B and 23C are schematic views showing a suction nozzle operation of the electronic component feeding method of Figs. 21A, 21B and 21C, wherein Fig. 23A shows a state in which a suction nozzle is descending, Fig. 23B shows a state in which the suction nozzle is brought into contact with an electronic component,

and Fig. 23C shows a state in which the electronic component is sucked and held and picked up;

Fig. 24 is a schematic plan view of a conventional tray plate;

Fig. 25 is a schematic sectional view of a conventional fixation bar;

Fig. 26 is a schematic sectional view of a fixation bar according to another conventional example; and

Fig. 27 is a sectional view of a fixation bar according to a modification example of the fixation bar of Fig. 15.

Detailed Description Of The Preferred Embodiments

Before description of the present invention proceeds, it is to be noted that like components are designated by like reference numerals throughout the accompanying drawings.

(First Embodiment)

A first embodiment of the present invention will be described in detail below with reference to drawings.

Fig. 1 shows an external perspective view (illustrated partially transparently) of an electronic component mounting apparatus 101 provided with an electronic component feeder 100 according to the first embodiment of the present invention.

As shown in Fig. 1, the electronic component mounting apparatus 101, which performs component mounting for mounting a plurality of fed electronic components onto a circuit board, is provided with the electronic component feeder 100 (this may be referred to as a tray component feeder) that feedably accommodates a plurality of electronic components arranged in alignment on a tray removably on an illustrated rearward side of a machine base 102 of the electronic component mounting apparatus 101 and provided with a tape-carried component feeder 103, which feeds a plurality of tape-carried electronic components accommodated arranged in alignment in a line, and is located on an illustrated frontward side of the machine base 102. The tape-carried component feeder 103 mainly feeds electronic components of small-size chip components and the like, while the electronic component feeder 101 feeds electronic components of a size comparatively larger than the chip components and electronic components that have specific shapes, such as IC components of, for example, QFP (Quad Flat Package) and BGA (Ball Grid Array) and the like.

As shown in Fig. 1, the electronic component mounting apparatus 101 has a stage 104, that is arranged in a roughly central portion of the machine base 102, for fixing a circuit board fed to the electronic component

mounting apparatus 101 releasably, and a head section 105 for mounting each of electronic components fed from the electronic component feeder 100 or the tape-carried component feeder 103 onto a circuit board fixed on the stage 104. An unloader 106, for unloading a tray, which is removably loaded in the electronic component feeder 100, for bringing each of the electronic components arranged on this unloaded tray into a state in which each of the components can be picked up by the head section 105, is provided on the machine base 102 located between the electronic component feeder 100 and the stage 104. It is to be noted that a position in which the tray unloaded by this unloader 106 is arranged is an electronic component feed position 107.

Next, a longitudinal sectional view showing a schematic structure of the electronic component feeder 100 is shown in Fig. 2. Fig. 3 shows a schematic perspective view of a tray loaded in the electronic component feeder 100.

As shown in Fig. 3, a plurality of electronic components 1 are arranged in alignment on an upper surface of a tray 2 that has a roughly quadrangular plate-like shape. The tray 2 is placed on an upper surface of a pallet 3 that has a roughly quadrangular plate-like shape. A plurality of pallets 3 on each of which such tray 2 is

thus placed are loaded in a stack vertically at regular intervals in the electronic component feeder 100.

As shown in Fig. 2, the electronic component feeder 100 has a magazine 4, that is a box to be loaded with a plurality of pallets 3 in a stack as described above, and a main body section 5 that is a box-shaped casing that receives this magazine 4 elevatably along an inside thereof and serves as one example of a magazine receiver.

Moreover, as shown in Fig. 2, the main body section 5 of the electronic component feeder 100 is arranged adjacently to the machine base 102 of the electronic component mounting apparatus 101. A pallet feed port 6, which is an opening to unload pallet 3 by the unloader 106 arranged on the machine base 102, is provided on the left-hand side in this figure, and the pallet 3 can be unloaded from inside the magazine 4 through this pallet feed port 6 by the unloader 106. In Fig. 2, a leftward direction is an unloading direction of each pallet 3 by the unloader 106, i.e., a pallet feed direction A.

Moreover, as shown in Fig. 2, the electronic component feeder 100 has a magazine elevation unit 8 for moving up and down the magazine 4 inside the main body section 5. The magazine elevation unit 8 has a magazine support base 10 for supporting the magazine 4 in its lower portion, a ball screw shaft section 11 that is arranged in

a vertical direction in this figure and is fixed to the main body section 5 rotatably around an axis thereof, a nut section 12 that is meshed with this ball screw shaft section 11 and fixed to the magazine support base 10, and an elevation drive motor 13 for drivingly rotating the ball screw shaft section 11 around its axis selectively in either a forward or reverse rotational direction. By rotating the elevation drive motor 13 in either the forward or reverse rotational direction, the nut section 12 can be moved up or down along the ball screw shaft section 11, by which the magazine 4 supported on the magazine support base 10 can be moved up and down along the inside of the main body section 5. When one selected pallet 3 is unloaded from among the pallets 3 loaded in the magazine 4, by moving up and down the magazine 4 by the magazine elevation unit 8 so that this selected pallet 3 is located in a height position of the pallet feed port 6, the pallet 3 located in the height position can be unloaded through the pallet feed port 6 by the unloader 106.

Moreover, as shown in Fig. 2, a plurality of rack sections 14, which is one example of a support section that has a recessed cross-sectional configuration, are formed with a constant spacing pitch in the vertical direction on mutually opposed inner side surfaces of the magazine 4 in a direction perpendicular to the pallet feed direction A

(i.e., direction perpendicular to the sheet plane of Fig. 2). The rack sections 14 are formed in a groove-like form so as to extend along the pallet feed direction A on inner side surfaces of the magazine 4 and able to support edge portions of the pallet 3 on these mutually opposed rack sections 14, i.e., a pair of rack sections 14, and to move the pallet 3 in a supported state in a direction in which the rack sections 14 are formed, i.e., along the pallet feed direction A.

Here is described more in detail structure of the pallet 3 referring back to Fig. 3. As shown in Fig. 3, edge portions, in the direction perpendicular to the pallet feed direction A, out of four edge portions of the pallet 3 serve as support side edge portions 3c movably supported by a pair of rack sections 14 of the magazine 4 as described above. An edge portion of the pallet 3 located on a forward side (on this side in Figure 3) in the pallet feed direction A serves as a forward side edge portion 3a, and protruding grip portions 3d to grip the pallet 3 by the unloader 106 are formed at the forward side edge portion 3a. An edge portion of the pallet 3 located on a rearward side (far side in Figure 3) in the pallet feed direction A serves as a rearward side edge portion 3b.

Fig. 4 shows a schematic partial sectional view of a cross section perpendicular to the pallet feed

direction A of the magazine 4 in a state in which the pallets 3 are supported and loaded on the respective rack sections 14. As shown in Fig. 4, support side edge portions 3c of the pallets 3 are supported in an engagement manner by the mutually opposed respective rack sections 14 in the magazine 4. In the above-mentioned state, the pallets 3 are stacked at the aforementioned regular intervals without being put in contact with one another, with roughly horizontal support postures thereof maintained with interposition of constant gaps.

Next, a cross-sectional view taken along line B-B of the electronic component feeder 100 of Fig. 2 is shown in Fig. 5. Although a state in which no pallet 3 is loaded in the magazine 4 is shown in the electronic component feeder 100 of Fig. 2, Fig. 5 shows a state in which the pallets 3 are loaded in the magazine 4 for sake of easy understanding of the following description.

As shown in Fig. 5, two magazines 4 are mutually adjacently received in the main body section 5 of the electronic component feeder 100. A plurality of large-size pallets 3L, on which large-size trays 2L are placed, is loaded in a large-size magazine 4L located on the right-hand side in this figure, while a plurality of small-size pallets 3S, on which small-size trays 2S are placed, is loaded in a small-size magazine 4S located on the left-hand

side in the figure. The magazines 4L and 4S can be individually moved up and down by mutually independent magazine elevation units 8.

Although an example in which two types of magazines 4 are received in the main body section 5 will be described in connection with the present embodiment, the present embodiment is not limited to this case, and is allowed to be applied to a case where only one type of magazine 4 is received or a case where three or more types of magazines 4 are received instead of the above-mentioned case.

In the following description, the large-size magazine 4L or the small-size magazine 4S is referred to as the magazine 4 when not limitedly used, and similarly, the large-size pallet 3L or the small-size pallet 3S is referred to as the pallet 3 when not limitedly used.

As shown in Fig. 5, the main body section 5 has an inner wall 5a. With this inner wall 5a serving as a boundary, a large-size magazine receiving chamber 16L for receiving the large-size magazine 4L is formed on the right-hand side in this figure, and a small-size magazine receiving chamber 16S for receiving the small-size magazine 4S is formed on the left-hand side in the figure.

Moreover, as shown in Fig. 5, the large-size magazine receiving chamber 16L has forward guide sections

18, as one example of a forward-side regulating member, for coming into contact with a neighborhood of both end portions of the forward side edge portion 3a of the large-size pallet 3L loaded in the magazine 4L and to regulate a movement position (or support position) on the forward side in the pallet feed direction of the large-size pallet 3L by such contact. Moreover, the forward guide sections 18, which are fixed to the main body section 5 so as to extend along an entire length in the vertical direction within a range of elevation of the large-size magazine 4L, are not provided in portions corresponding to the pallet feed port 6 for unloading each pallet 3. It is to be noted that the small-size magazine receiving chamber 16S is similarly provided with forward guide sections 18.

Moreover, as shown in Fig. 5, the rearward side of the main body section 5 in the pallet feed direction A serves as a pallet loading side for performing loading, replacement or the like of each pallet 3, and the main body section 5 has two outer doors 20, which serve as one example of an openable receiver door section, on this pallet loading side. The outer doors 20 can be opened on both sides of a placement position of the inner wall 5a serving as a boundary, and only one outer door 20 can be selectively opened independently. For example, when only the outer door 20 located on the right-hand side in Figure

5 is opened, only the large-size magazine receiving chamber 16L can be opened.

On the rearward side in the pallet feed direction A, each magazine 4 has an inner door 22 as one example of an openable magazine door section for performing loading or the like of the pallets 3 into the magazine 4. Each of inner doors 22 is formed so as not to cover an entire rearward side surface of the magazine 4 in the pallet feed direction A but to cover only about one third of this surface.

Further, the inner doors 22 of the large-size magazine 4L are internally provided with a rearward guide section 24, which is one example of a rearward-side regulating member for regulating a movement position (or support position) on the rearward side in the pallet feed direction A by being brought into contact with the rearward side edge portion 3b of each of the large-size pallets 3L loaded in the magazine 4L loaded in the large-size magazine receiving chamber 16L. This rearward guide section 24 is formed on the inner door 22 so as to extend from an upper end to a lower end of the magazine 4L in the vertical direction, and is movable along the pallet feed direction A in accordance with pivoting of the inner door 22. Further, in the magazine 4L, the inner door 22 is closed in a state in which both end portions of the forward side edge portion

3a of the large-size pallet 3L are brought into contact with the forward guide sections 18, and its movement position in the pallet feed direction A is regulated and in a state in which the rearward guide section 24 is brought into contact with the rearward side edge portion 3b of the large-size pallet 3L (i.e., the state shown in Fig. 5). Further, a bumper section 25 for bumping against an outside of a corresponding inner door 22 is formed inside the outer door 20, so that the outer door 20 can be completely closed with the bumper section 25 brought into contact with the outside of the inner door 22 only in a state in which the inner door 22 is completely closed as described above. Therefore, the outer door 20 is constructed unclosable in a state in which the corresponding inner door 22 is not completely closed, since the bumper section 25 is brought into contact with the outside of inner door 22 that is not closed, and a pivotal position of the outer door 20 is regulated. It is to be noted that a rearward guide section 24 is similarly provided inside the inner door 22 of the small-size magazine 4S.

Moreover, as shown in Figs. 2, 4 and 5, a combteeth-shaped combteeth guide section 26 (one example of a horizontal posture regulating member), which has a plurality of projections 26a vertically arranged at the same formation interval as the formation interval of the

rack sections 14, is provided inside each of the inner doors 22. The projections 26a in the combteeth guide section 26 can be arranged so as to be inserted into gaps between the pallets 3 loaded stacked in the magazine 4. In concrete, by closing the inner door 22 of the magazine 4L loaded with the large-size pallets 3L, the projections 26a can be inserted in the gaps between the large-size pallets 3L. As described above, it can be detected whether or not the large-size pallets 3L are each securely supported by a pair of mutually opposed rack sections 14, i.e., whether or not the large-size pallets 3L are each supported in a roughly horizontal support posture in the magazine 4 by inserting the projections 26a in the gaps.

Moreover, as shown in Fig. 4, each of the projections 26a of the combteeth guide section 26 has a height, so that each projection 26a is slightly smaller than a height dimension of the gap between the large-size pallets 3L in a stacked state, so that none of the projections 26a is brought into contact with the large-size pallets 3L when the large-size pallets 3L are each loaded in a state in which the roughly horizontal support posture is maintained.

Further, as shown in Fig. 5, each of the projections 26a has a length in the pallet feed direction A, so that the projection does not reach a region where the

electronic components 1 in the large-size tray 2L placed on the large-size pallet 3L are arranged even in a state in which the projection 26a is arranged between the large-size pallets 3L. Therefore, even in a case where electronic components 1 having an especially large height are arranged in the large-size tray 2L and the large-size tray 2L is placed on the large-size pallet 3L and loaded in the magazine 4L, fore ends of the projections 26a of the combteeth guide section 26 do not come into contact with the electronic components 1 arranged in the large-size tray 2L, thereby reliably preventing occurrence of damage of the electronic components 1 due to such contact.

Moreover, as shown in Fig. 5, combteeth guide sections 26 are arranged closer to the rack section 14 located on the right-hand side with respect to a position roughly intermediate between mutually opposed rack sections 14 in the magazine 4L, while the combteeth guide sections 26 are arranged closer to the rack section 14 located on the left-hand side with respect to a position roughly intermediate between mutually opposed rack sections 14 in the magazine 4S. The combteeth guide sections 26 are formed so as to extend from the upper end to the lower end of the magazine 4. Moreover, the combteeth guide sections 26 inserted between the large-size pallets 3L are provided on the inner door 22 of the large-size magazine 4L. With

this arrangement, the combteeth guide sections 26 are moved up and down together with the large-size pallets 3L even if the large-size magazine 4L is moved up and down by the magazine elevation unit 8, and therefore, an elevation operation of the large-size magazine 4L is not hindered.

In this case, one example of dimensions of the combteeth guide sections 26 is shown in Fig. 11 (a schematic partial sectional view of a cross section perpendicular to the pallet feed direction A) with regard to the small-size magazine 4S, and in Fig. 12 (a schematic partial sectional view of a section similar to the above) with regard to the large-size magazine 4L. As shown in Fig. 11, in the small-size magazine 4S, the dimensions are set so that a width W between a pair of rack sections 14 is 170 mm, an interval (pitch) P of the rack sections 14 is 13.5 mm, a thickness T of the small-size pallet 3S is 6 mm, a height H of the projection 26a of the combteeth guide section 26 is 4.5 mm, a gap height D of a space between an upper surface or a lower side of the small-size pallet 3S and a nearmost projection 26a is 1.5 mm, and a distance L between each projection 26a and the rack section 14 (rack section 14 located on an adjacent side) is 56 mm. Moreover, as shown in Fig. 12, in the large-size magazine 4L, the dimensions are set so that a width W between a pair of rack sections 14 is 260 mm, a interval (pitch) P of the rack

sections 14 is 13.5 mm, a thickness T of the large-size pallet 3L is 6 mm, a height H of the projection 26a of the combteeth guide section 26 is 4.5 mm, a gap height D of a space between an upper surface or a lower side of the large-size pallet 3L and a nearmost projection 26a is 1.5 mm, and a distance L between each projection 26a and the rack section 14 (rack section 14 located on an adjacent side) is 87 mm. It is preferable to set the distance L between each projection 26a and the rack section 14 to a dimension about one third of the width W between a pair of rack sections 14 (i.e., L = 1/3W or a dimension about one third of the width of the pallet 3) for reasons described later.

Further, as shown in Fig. 5, each of the outer doors 20 is provided with a door opening/closing detection section for detecting opening or closing of the outer door 20, and this door opening/closing detection section has a safety switch dog 28 provided in a lower portion of an open side end portion of each outer door 20 and a safety switch 29 engaged with the safety switch dog 28 in a state in which each outer door 20 is completely closed.

Fig. 6 shows a state in which the outer doors 20 and the inner doors 22 are opened at the electronic component feeder 100. In this state, regulation of a movement position on a rearward side in the pallet feed

direction A of the pallets 3 (i.e., the large-size pallets 3L and the small-size pallets 3S) loaded in the magazines 4L and 4S is released. Therefore, it is possible to perform replacement of each pallet 3 by unloading, loading of a new pallet 3 and so on.

Moreover, as shown in Fig. 2, the electronic component feeder 100 has a control unit 9, for controlling the elevation operation of the magazines 4 by respective magazine elevation units 8 and detection of an open/closed state of each of the outer doors 20 by respective safety switches 29 and safety switch dogs 28. The control unit 9 can execute the above-mentioned control operations in correlation with a control operation of a mounting control unit that controls a mounting operation of the electronic components 1 in the electronic component mounting apparatus 101.

In concrete, the control unit 9 can execute, for example, control of an elevation operation by the magazine elevation unit 8 so that one pallet 3 loaded in the magazine 4 of the electronic component feeder 100 is selected according to a type of electronic component 1 to be mounted on a circuit board, and this selected pallet 3 is positioned in a height position of the pallet feed port 6, and the pallet 3, positioned in the height position, is put into an unloadable state by the unloader 106.

Moreover, there is provided an interlock that stops the elevation operation by the magazine elevation unit 8 when an open state of the outer door 20 is detected by either the safety switch 29 or the safety switch dog 28 on an assumption that a loading state (support posture) of the pallet 3 loaded in either of the magazines 4L or 4S is abnormal. There is further provided a display section 19 that operates, when the open state of the outer door 20 as described above is detected, to display information of this event while allowing an operator to recognize the information.

A method for detecting occurrence of abnormality in a support posture (or loading posture) of the pallet 3 loaded in the magazine 4 in the electronic component feeder 100 of the aforementioned construction will be described below by way of a concrete example. Figs. 7A and 7B show schematic sectional views of a cross section perpendicular to the pallet feed direction A of the large-size magazine 4L in which the pallet 3 having the aforementioned abnormality in the support posture is loaded, while Figs. 8A and 8B show schematic sectional views of the small-size magazine 4S. Figs. 9 and 10 show schematic sectional views of a cross section perpendicular to a stacking direction of the pallet 3 in the electronic component feeder 100 in such state.

First of all, Figs. 4 and 5 show a state in which the pallets 3 are loaded in a normal support posture in the magazine 4 of the electronic component feeder 100. There are two requirements for a loaded pallet 3 to keep this normal support posture in the magazine 4. As a first requirement, the forward side edge portion 3a of the pallet 3 is required to be directed in the pallet feed direction A (this arrangement is referred to as a forwardly directed support posture in the pallet feed direction A) as shown in Fig. 5. Further, as a second requirement, the support side end portions 3c of the pallet 3 are required to be supported by a pair of mutually opposed rack sections 14, i.e., in a state in which the roughly horizontal support posture is maintained as shown in Fig. 4. If either one of the above-mentioned requirements is not satisfied, the pallet 3 is loaded not in a correct support posture, and there is abnormality in the support posture. In the above case, there possibly occur not only hindrance in the elevation operation of the magazine 4 by the magazine elevation unit 8 and an unloading operation of the pallet 3 by the unloader 106, but also damage of the pallet 3 and the electronic component feeder 100 itself due to the operation.

As shown in Fig. 9, in the small-size magazine receiving chamber 16S in the electronic component feeder

100, the forward side edge portion 3a of the small-size pallet 3S is arranged so as to be directed in a direction reverse to the pallet feed direction A (i.e., this posture is referred to as a reversely directed support posture in the pallet feed direction A). In concrete, end portions of the rearward side edge portion 3b of the small-size pallet 3S are brought into contact with the forward guide sections 18, so that a support position on the forward side in the pallet feed direction A is regulated by this contact. If it is tried to close the inner door 22 of the small-size magazine 4S in the above-mentioned state, the protruding grip portion 3d formed at the forward side edge portion 3a of the small-size pallet 3S is brought into contact with the rearward guide section 24 provided inside the inner door 22, as a consequence of which a position where the small-size pallet 3S is brought into contact with the rearward guide section 24, i.e., a pivotal position of the inner door 22 is limited and put into an unclosable state. Further, the bumper section 25 of the outer door 20 (outer door 20 for the small-size magazine receiving chamber 16S) is brought into contact with an outside of the inner door 22, and pivoting for closing the outer door 20 itself is limited, thereby failing in completely closing the door. In this case, since the safety switch dog 28 of the outer door 20 cannot be engaged with the safety switch 29, it is

possible to make the control unit 9 display an event that the outer door 20 cannot be completely closed in the display section 19, and allow the operator recognize the event. The operator, who has recognized the display, is able to recognize that the small size pallet 3S having abnormality in its support posture is included in the small-size magazine 4S, i.e., inclusion of the small-size pallet 3S loaded in a reversely directed support posture, and to take necessary measures. A recognition method (detection method) of the pallet 3 in a case where a reversely directed pallet 3 is included in the magazine 4 can be similarly performed for the large-size magazine 4L.

Moreover, the plurality of large-size pallets 3L is loaded in the large-size magazine 4L as shown in Fig. 7A, where one large-size pallet 3L is put in a state in which the pallet is supported by rack sections 14, one of which is displaced by two steps, without being supported by one pair of mutually opposed rack sections 14 by its side edge portions 3c. That is, the support side edge portions 3c are supported by the rack sections 14 that are not mutually opposed and put in a state in which the pallet is supported in an inclined support posture without maintaining a roughly horizontal support posture.

In the above case, if it is tried to close the inner door 22 of the large-size magazine 4L as shown in Fig.

10, then an end portion of the projection 26a of the combteeth guide section 26 provided inside the inner door 22 comes into contact and interferes with the rearward side edge portion 3b of the large-size pallet 3L in an inclined support posture (see Fig. 7A). Therefore, a pivotal position of the inner door 22 is limited (regulated) without inserting the projections 26a of the combteeth guide section 26 between the large-size pallets 3L, thereby failing in completely closing the door. Pivoting of the outer door 20 (outer door 20 for the large-size magazine receiving chamber 16L) in a state in which the bumper section 25 is brought into contact with the outside of the inner door 22 is also limited (regulated), thereby failing in completely closing the door. As a result, since the safety switch dog 28 of the outer door 20 cannot be engaged with the safety switch 29, it is possible to make the control unit 9 display an event that the outer door 20 cannot be completely closed in the display section 19, and to allow the operator recognize the event. The operator, who has recognized the display, is able to recognize that the large-size pallet 3L loaded in an inclined support posture is included in the large-size magazine 4L and to take necessary measures. If the projection 26a of the combteeth guide section 26 is brought into contact with the large-size pallet 3L as described above, the projection 26a

does not interfere directly with the large-size tray 2L and the electronic components 1 arranged on this large-size tray 2L since a position of contact is an edge portion of the large-size pallet 3L. A recognition method (detection method) of the pallet 3 in a case where the pallet 3 in the aforementioned inclined support posture is included in the magazine 4 can be similarly performed for the small-size magazine 4S as shown in Fig. 10.

A state of the large-size magazine receiving chamber 16L shown in Fig. 9 is a state in which a large-size pallet 4L having the reversely directed support posture and the inclined support posture is loaded in the large-size magazine 4L. In this state, projection 26a of the combteeth guide section 26 is brought into contact with the forward side edge portion 3a of the large-size pallet 3L, and insertion of the projections 26a is limited, so that the inner door 22 and the outer door 20 cannot be completely closed.

Moreover, a formation height of the projections 26a and an arrangement of the combteeth guide section 26 in a horizontal direction in Figs. 7A and 7B are determined so that the projections 26a of the combteeth guide section 26 interfere with not only the large-size pallet 3L, that has the inclined support posture and is supported by rack sections 14 displaced by two steps by its side edge

portions 3c in the large-size magazine 4L as shown in Fig. 7A, but also the large-size pallet 3L that has the inclined support posture and is supported by rack sections 14 displaced by one step. By thus forming and arranging the combteeth guide section 26, the inclined support postures displaced by one step, two steps or the like, which tend to be rather neglected by the operator, can reliably be detected.

It is to be noted that Figs. 8A and 8B show a state of the small-size magazine 4S corresponding to the large-size magazine 4L described with reference to Figs. 7A and 7B. Since similar contents as those of the description of Figs. 7A and 7B are possessed, no description is provided for Figures 8A and 8B.

Moreover, when an abnormality of the support posture of the pallet 3 in the magazine 4 is detected by limited closing of the outer door 20, it is possible to interlockingly stop driving of the magazine elevation unit 8 by the control unit 9, and further stop operation of the electronic component mounting apparatus 101 equipped with the electronic component feeder 100.

Although there has been described hereinabove a case where the plurality of projections 26a inserted between the pallets 3 is formed in the combteeth guide section 26 that regulates the roughly horizontal support

posture of the pallets 3 and is able to detect the inclined support posture, the present embodiment is not limited only to the above-mentioned case. In place of the above-mentioned case, it is acceptable to form, for example, a plurality of rod-shaped or plate-shaped members so that the members are provided along a side surface on which the rack sections 14 are formed and are arranged between pallets 3 in the magazine 4. In this case, there is an advantage in that loading itself of pallet 3 in an inclined support posture can be prevented since a horizontal support posture of the pallet 3 is regulated when the pallet is loaded in the magazine 4.

Moreover, although one example of the configuration of the pallet 3 used for the electronic component feeder 100 is shown in Fig. 3, the configuration is not limited only to such configuration. Any configuration can be used in place of that of Fig. 3 so long as the configuration is accepted in the magazine 4 and a regulated position (position in which the pallet 3 is brought into contact with the rearward guide section 24) by the rearward guide section 24 is different between a forwardly directed support posture and a reversely directed support posture in a state in which the support position on the forward side is regulated by the forward guide section 18.

Moreover, there has been described a case where the tray 2, on which the plurality of electronic components 1 is arranged in alignment, is placed on the upper surface of the pallet 3 as shown in Fig. 3. However, in place of this arrangement, it is acceptable to integrally form the tray 2 with the pallet 3 and load the tray 2 directly into the magazine 4 instead of the pallet 3.

By making it possible to easily identify a combination of a pair of rack sections 14 with a serial number or an identification color attached to the rack sections 14 of each magazine 4, so that a pair of rack sections 14 has an identical number or an identical color, in place of or in addition to a method of preventing the insertion of the pallet 3 in the inclined support posture into the magazine 4 as described above, it is possible to attract the operator's attention in advance.

Moreover, it is also possible to provide the pallets 3 individually with a level and display a warning for attracting the operator's attention (by using, for example, a color display or the like) to the level when the pallet 3 is inserted in the inclined support posture into the magazine 4.

Moreover, it is also acceptable to use a method for flowing a feeble current through mutually paired rack sections 14 in the magazine 4, and detecting the current

when the pallet 3 is inserted in a normal support posture.

According to the first embodiment, the following various effects can be obtained.

First of all, the electronic component feeder 100 has the forward guide section 18 that regulates the support position of each pallet 3 loaded in the magazine 4 by the rack sections 14 by being brought into contact with the edge portion of pallet 3 on the forward side in the pallet feed direction A, and the rearward guide section 24 that is provided for the inner door 22 movably along the pallet feed direction A and regulates the pallet 3 regulated by the forward guide section 18 by being brought into contact with the edge portion of the pallet 3 on the rearward side in the pallet feed direction A. With this arrangement, when the pallet 3, which is provided with the grip portions 3d at the forward side edge portion 3a thereof and formed so as to have mutually different forward side and rearward side edge configurations, is loaded in magazine 4, it can be detected that a pallet 3 loaded in the reversely directed support posture is included among loaded pallets 3 on the basis of a difference in a regulation position (contact position) by the rearward guide section 24.

Furthermore, by providing the inner door 22 with the combteeth guide section 26, where a plurality of projections 26a to be inserted in the gaps between the

pallets 3 loaded in the magazine 4 are formed, when all the projections 26a are inserted into the gaps, it can be detected that the pallets 3 are loaded with a roughly horizontal support posture maintained without being inclined. When any projection 26a comes into contact and interferes with the edge portion of any pallet 3, thereby failing in inserting the projections 26a in the gaps, it can be detected that there is included a pallet 3 in the inclined support posture.

Moreover, the inner door 22 is provided with the rearward guide section 24 and the combteeth guide section 26. There is an arrangement that the inner door 22 can be closed in a position where the edge portion of the pallet 3 loaded in the forwardly directed support posture is brought into contact with the rearward guide section 24, the inner door 22 cannot be closed in a position where the edge portion of the pallet 3 loaded in the reversely directed support posture is brought into contact with the rearward guide section 24, and the inner door 22 cannot be closed even when the combteeth guide section 26 interferes with the pallet 3. With this arrangement, it can be detected whether or not there is an abnormality in the support posture of each pallet 3 in the magazine 4, i.e., whether or not there is included a pallet 3 in the reversely directed support posture or the inclined support posture

based on whether or not the inner door 22 can be closed.

Therefore, an abnormality of the support posture of each pallet 3 loaded in the magazine 4 can be reliably easily detected and the pallet 3 can be loaded consistently in a correct support posture in the electronic component feeder 100. Therefore, an operation stop of the electronic component mounting apparatus 101 attributed to the above-mentioned support postures of the pallets 3 and damage or the like of constituent components of the electronic component feeder 100 can be prevented.

Moreover, because the electronic component feeder 100 is provided with the outer door 20 that can be closed only when the inner door 22 is closed, the safety switch 29 and the safety switch dog 28 for detecting opening/closing of this outer door 20, and further with the display section 19 that can display this result of the opening/closing while allowing the operator to recognize the result, the operator is allowed to more reliably recognize an open/closed state of the inner door 22.

Moreover, with the inner door 22 provided for the magazine 4 and the outer door 20 provided for the main body section 5 as described above, the inner door 22 can be moved up and down integrally with the magazine 4, and the elevation operation of the magazine 4 is not hindered even when the combteeth guide section 26 is provided for the

inner door 22.

Moreover, with the combteeth guide section 26 positioned not in the vicinity of a position intermediate the mutually opposed rack sections 14 in the magazine 4 but closer to either one of the rack sections 14 away from this intermediate position, the projection 26a of the combteeth guide section 26 can more reliably come into contact and interfere with the pallet 3 in the inclined support posture.

Moreover, by virtue of the arrangement that the combteeth guide section 26 is arranged in position so as to interfere with the pallet 3 supported by the rack sections 14 displaced by two steps and the pallet 3 supported by the rack sections 14 displaced by one step, and the arrangement that a dimensional relationship between the formation height of each projection 26a and the gap between the pallets 3 is determined as described above, inclined support postures displaced by one step and by two steps, which tend to be rather neglected by the operator, can reliably be detected.

Moreover, each projection 26a has a dimension of length so that the end of each projection 26a of the combteeth guide section 26 does not reach a region where the electronic components 1 are arranged in the tray 2 placed on the pallet 3 even when the inner door 22 is completely closed, and the projection 26a is prevented from

coming into contact with the electronic components 1 and from damaging the electronic components 1 in any case. Since comparatively expensive electronic components 1 such as IC chips are arranged on the tray 2 as described above, a capability of preventing occurrence of damage of electronic components 1 as described above also reduces a manufacturing cost in component mounting, and allows efficient component mounting to be achieved.

(Second Embodiment)

The present invention is not limited to the aforementioned embodiment but allowed to be put into practice in various other forms. For example, a tray plate structure capable of performing stable efficient electronic component feeding while preventing a leap-up or the like of an electronic component from a component feed tray by devising a method for fixing the component feed tray on the tray plate, as one example of a pallet in the electronic component feeder 100 of the first embodiment, or an electronic component feeder that has another construction will be described below as a second embodiment of the present invention.

Fig. 13A shows a plan view of a tray plate 503, as one example of a placement section where a component feed tray handled in the electronic component feeder according to the present second embodiment, is placed (also

as one example of the pallet), and Fig. 13B shows a side view of the tray plate 503. Moreover, Fig. 14A shows a plan view in a state in which the component feed tray is placed on this tray plate 503, and Fig. 14b shows a side view of the component feed tray placed on the tray plate.

As shown in Figs. 13A, 13B, 14A and 14B, the tray plate 503 has a roughly flat-plate-like rectangular shape and includes a placement surface (this may be a placement region) that receives a component feed tray 502, on an upper surface of which a plurality of electronic components 501 as one example of electronic components are arranged while allowing the components to be picked up. This tray placement surface 504 is formed as a roughly quadrangular flat surface region formed within the upper surface of the tray plate 503 surrounded by peripheral portions. A component feed tray 502 can be arranged so as to be positioned on this tray placement surface 504.

Such tray plate 503 is used for feeding electronic components to a component mounting apparatus for mounting the electronic components onto a circuit board. A plurality of the tray plates 503, each of which carries a component feed tray 502 placed thereon, is loaded in layers into a magazine or the like and unloaded from the magazine according to a type of electronic components to be mounted onto the circuit board. A desired electronic component is

sucked and held and picked up from the component feed tray 502 placed on an unloaded tray plate 503 by a suction nozzle as one example of a component suction and holding member of a component mounting apparatus, and the electronic components can be mounted onto the circuit board by the component mounting apparatus.

A construction of this tray plate 503 will be described in detail as follows. As shown in Figs. 13A and 13B, an engagement portion 503a having a concave configuration is formed at an end portion, which is located on the left-hand side in this figure, of the tray plate 503. By engaging this engagement portion 503a with a pullout portion of a tray plate pullout unit (not shown), the tray plate 503 can be advanced and retreated in an illustrated X-axis direction. With this movable arrangement, for example, the tray plate 503 loaded in the magazine can be pulled out of the magazine or loaded into the magazine by an advancing and retreating movement.

Moreover, as shown in Figs. 13A and 13B, the component feed tray 502 is placed on the tray placement surface 504 of the tray plate 503 with an illustrated lower left corner portion serving as a reference position. Therefore, the tray plate 503 is provided with an X-axis direction reference position regulating member 510 (hereinafter referred to as an X-axis reference member 510)

as one example of a reference position regulating member for regulating movement of the component feed tray 502 arranged in a reference position leftward in the illustrated X-axis direction, and a Y-axis direction reference position regulating member 512 (hereinafter referred to as a Y-axis reference member 512) as one example of a reference position regulating member for regulating movement downward in an illustrated Y-axis direction. This X-axis reference member 510 has an X-axis direction reference surface 510a (hereinafter referred to as an X-axis reference surface 510a), which is formed along the illustrated Y-axis direction and able to regulate the component feed tray 502 in the X-axis direction (i.e., lengthwise direction) by being brought into contact with an end portion of the component feed tray 502. The Y-axis reference member 512 has a Y-axis direction reference surface 512a (hereinafter referred to as a Y-axis reference surface 512a), which is formed along the illustrated X-axis direction and able to regulate the component feed tray 502 in the Y-axis direction (i.e., horizontal direction) by being brought into contact with an end portion of the component feed tray 502. In the present second embodiment, the X-axis direction and the Y-axis direction are directions along tray placement surface 504 and mutually perpendicular directions. Moreover, the X-axis reference

member 510 and the Y-axis reference member 512 are fixed to the neighborhood of respective edge portions of the tray plate 503 by, for example, being screwed or by another manner. In the present second embodiment, for example, the engagement portion 503a is formed integrally with the X-axis reference member 510 and formed on a surface opposite from a surface located on a side on which the X-axis reference surface 510a is formed at the X-axis reference member 510.

Moreover, as shown in Figs. 13A and 13B, the tray plate 503 is provided with an X-axis direction fixation bar 514 (hereinafter referred to as an X-axis fixation bar 514) as one example of a fixation bar that has a rod-shaped configuration and is able to regulate rightward movement in the illustrated X-axis direction of the component feed tray 502 in a state in which respective end portions of the component feed tray are brought into contact with the X-axis reference surface 510a of the X-axis reference member 510 and the Y-axis reference surface 512a of the Y-axis reference member 512, and a Y-axis direction fixation bar 516 (hereinafter referred to as a Y-axis fixation bar 516) as one example of a fixation bar that has a rod-shaped configuration and is able to regulate upward movement in the illustrated Y-axis direction of the component feed tray 502 in the above-mentioned state. The X-axis fixation bar

514 and the Y-axis fixation bar 516 have, for example, a mutually identical configuration and are able to magnetically releasably fix their arrangement positions in arbitrary positions on the tray placement surface 504 by use of built-in magnets.

Figs. 14A and 14B show a state in which a placement position of the component feed tray 502 is placed on the tray placement surface 504 by use of the X-axis fixation bar 514 and the Y-axis fixation bar 516 as described above. As shown in Figs. 14A and 14B, with respect to the end portions of the component feed tray 502 in the state in which movement thereof in the illustrated X-axis leftward direction and Y-axis downward direction are regulated by bringing the end portions into contact with the X-axis reference member 510 and the Y-axis reference member 512 on the tray placement surface 504 of the tray plate 503, the X-axis fixation bar 514 and the Y-axis fixation bar 516 are arranged on the tray placement surface 504 so as to be brought into contact with the end portions located on sides opposite (i.e., opposite sides) from the end portions. Further, by magnetically fixing these bars so arranged, rightward movement in the illustrated X-axis direction and upward movement in the illustrated Y-axis direction of the component feed tray 502 can also be regulated. Therefore, a placement position of the

component feed tray 502 on the tray placement surface 504 can be fixed in the illustrated X-axis direction and Y-axis direction, i.e., in a direction (i.e., a first direction) along the tray placement surface 504.

Fig. 15 shows a schematic sectional view showing structure of the X-axis fixation bar 514 and the Y-axis fixation bar 516. In the present second embodiment, the X-axis fixation bar 514 and the Y-axis fixation bar 516 have a mutually identical structure, and therefore, Fig. 15 shows a cross section of the X-axis fixation bar 514 as a representative of each of these bars.

As shown in Fig. 15, the X-axis fixation bar 514 has a fixation surface 514a, which fixes the placement position of the component feed tray 502 in the X-axis direction by being brought into contact with the end portion 502a of the component feed tray 502. This fixation surface 514a is formed inclined at, for example, a prescribed angle θ with respect to a plane perpendicular to the tray placement surface 504. In other words, the fixation surface is formed inclined at a prescribed angle ($90° - \theta°$) without being perpendicular to the tray placement surface 504. This fixation surface 514a is formed so as to incline toward a component feed tray 502 side, with which it is to be brought into contact, vertically upwardly in Fig. 15. With the fixation surface

514a formed as described above, it becomes possible to regulate movement in the horizontal direction in this figure (i.e., X-axis direction) of the component feed tray 502 brought into contact with this fixation surface 514a, and to regulate also movement in a vertical direction in the figure. Therefore, by employing the X-axis fixation bar 514 and the Y-axis fixation bar 516 that have the above-mentioned structure, it becomes possible to fix the component feed tray 502 in the illustrated X-axis direction and Y-axis direction on the tray placement surface 504, and to concurrently fix the tray in a direction perpendicular to the tray placement surface 504.

Inclined fixation surface 514a of the X-axis fixation bar 514 serves as one example for fixation in the first direction that is a direction along the tray placement surface 504 (or as one example of a first direction fixation portion), and also serves as one example for fixation in a second direction that is a direction perpendicular to the tray placement surface 504 (or as one example of a second direction fixation portion). That is, the fixation surface 514a concurrently serves as a first direction fixation surface and a second direction fixation surface formed as an identical surface.

Moreover, as shown in Fig. 15, such fixation surface 514a is formed on another side of the X-axis

fixation bar 514. With the fixation surface 514a formed on both sides, a cross-sectional configuration of the X-axis fixation bar 514 can be made symmetrical, and either fixation surface 514a of the X-axis fixation bar 514 can be used. Therefore, handlability can be made satisfactory.

Moreover, instead of a case where the inclined fixation surfaces 514a are formed on both sides as described above, it is acceptable to form the inclined fixation surface 584a only on one side as X-axis fixation bar 584 shown in Fig. 27 and form a roughly perpendicular fixation surface 584c on the other side. In this case, replacement work of the component feed tray 502 can be facilitated by fixing the component feed tray 502 by the roughly perpendicular fixation surface 584c. In this case, in order to assure reliable fixation, it is required that warpage of the component feed tray 502 is comparatively small, weight of component 501 accommodated in the component feed tray 502 is comparatively heavy, and leap-up of the component 501 from the component feed tray 502 hardly occurs. Moreover, by fixing the component feed tray 502 by the inclined fixation surface 584a, fixation of the component feed tray 502 can be made reliable. Particularly, when the warpage of the component feed tray 502 is comparatively large, a strength is comparatively small and a weight of the component 501 accommodated in the component

feed tray 502 is comparatively light, whereby fixation of the component feed tray 502 can be effectively achieved. That is, it becomes possible to select an optimum fixation method by selecting between the fixation surfaces according to features of the component feed tray 502 as an object to be fixed. When the component feed tray 502 is fixed by the inclined fixation surface 584a, this fixed component feed tray 502 can be pressed against the tray placement surface 504 of the tray plate 503. Therefore, the component feed tray 502 and the tray plate 503 can be put into an integrated state, and strength of the component feed tray 502 and the tray plate 503 can be improved. The tray plate 503 can be formed of a sheet metal having a thickness of, for example, about 0.5 mm.

Moreover, as shown in Fig. 15, a magnet section 514b, which is one example of a magnetic member formed of a magnetic material, is built in a lower portion of the X-axis fixation bar 514, so that the X-axis fixation bar 514 can be magnetically releasably fixed in a desired position on the tray placement surface 504. Moreover, as shown in Fig. 27, by providing a gap G between a lower surface of magnet section 584b and the tray placement surface 504, there can be obtained a stronger magnetic field than in a state in which the lower surface of the magnet section 584b is brought into contact with the tray placement surface 504.

It is to be noted that a member, which forms the fixation surfaces 584a and 584c of the X-axis fixation bar 584, is formed by bending, for example, an iron plate.

Here, Fig. 16 shows a schematic explanatory view showing forces generated in the X-axis fixation bar 514 and the Y-axis fixation bar 516 (note that the forces generated in the X-axis fixation bar 514 are typified) when erroneous suction is performed by a suction nozzle on, for example, the component feed tray 502 in a state in which the placement position thereof is fixed and a suction force F is applied. In Fig. 16, it is assumed that a suction force applied to the component feed tray 502 by the suction nozzle is F, dead weight of the component feed tray 502 is mg (g: gravitational acceleration), magnetic retentivity in the X-axis fixation bar 514 is fm, an inclination angle of the fixation surface 514a of the X-axis fixation bar 514 is θ, a horizontal component of force generated in the fixation surface 514a of the X-axis fixation bar 514 due to the suction force F is Fs, a width dimension of a lower surface of the X-axis fixation bar 514 is W, and a height (thickness) dimension of the component feed tray 502 is H.

First of all, in order to prevent uplift of the component feed tray 502 from the tray plate 503 when erroneous suction is performed on the component feed tray 502 by the suction nozzle, it is required to satisfy a

condition of expression (1).

$$F < (mg + fm) \quad \ldots(1)$$

Moreover, taking a moment generated around a point A at an end portion on the lower surface of the X-axis fixation bar 514 in Fig. 16 into consideration, it is required to satisfy a condition of expression (2).

$$Fs \times H < fm \times W/2 \quad \ldots(2)$$

The horizontal component of force Fs generated on the fixation surface 514a of the X-axis fixation bar 514 is expressed by expression (3).

$$Fs = F \times \tan\theta \quad \ldots(3)$$

Therefore, the inclination angle θ of the fixation surface 514a can be determined on basis of the aforementioned conditions. The inclination angle θ can be determined within a range of, for example, about 1° to 30°.

Moreover, when the tray plate 503 on which the component feed tray 502 is placed is moved by being pulled out of the magazine, a horizontal force K based on acceleration α due to this movement is to be generated in the component feed tray 502, and this horizontal force K is expressed by expression (4).

$$K = mg \times \alpha \quad \ldots(4)$$

Moreover, also in a state in which the horizontal force K is applied to the component feed tray 502, there is needed a condition of expression (5) in order to reliably

fix and hold the component feed tray 502 on the tray plate 503. It is to be noted that μ is a coefficient of friction between the lower surface of the X-axis fixation bar 514 and the tray plate 503.

$$K < fm \times \mu \quad \ldots(5)$$

Moreover, taking a moment generated around point A at an end portion on the lower surface of the X-axis fixation bar 514 in Fig. 16 into consideration, it is required to satisfy also a condition of expression (6).

$$K \times H < fm \times W/2 \quad \ldots(6)$$

Therefore, the height (thickness) H of the component feed tray 502, the width dimension L of the lower surface of the X-axis fixation bar 514, and further the magnetic retentivity fm in the X-axis fixation bar 514, can be determined on basis of the aforementioned conditions.

It is to be noted that constructions of the X-axis fixation bar 514 and the Y-axis fixation bar 516, which are the fixation bars of the present second embodiment, are not limited to the aforementioned constructions but allowed to adopt other constructions. Several modification examples concerning the fixation bars will be described below.

First of all, Fig. 17 shows a schematic sectional view of, for example, an X-axis fixation bar 524 as one example of a fixation bar according to a first modification

example of the present second embodiment. As shown in Fig. 17, the X-axis fixation bar 524 is provided with a horizontal direction fixation surface 524a, which serves as one example of a first direction fixation portion and also as one example of a first direction fixation surface to fix a placement position of the component feed tray 502 in a direction along the tray placement surface 504 by being brought into contact with an end portion 502a of the component feed tray 502, and a vertical direction fixation spring (as one example of the urging member) 524c, which serves as one example of a second direction fixation portion and also as a second direction fixation surface to fix a placement position of the component feed tray 502 in a direction perpendicular to the tray placement surface 504 by being brought into contact with an upper portion of the end portion 502a of the component feed tray 502 brought in contact with the horizontal direction fixation surface 524a, and which always urges the end portion 502a toward the tray placement surface 504.

Moreover, as shown in Fig. 17, the horizontal direction fixation surface 524a is formed so as to be roughly perpendicular to the tray placement surface 504 and able to come into surface contact with an end surface of the end portion 502a of the component feed tray 502 formed similarly roughly perpendicularly. Further, the vertical

direction fixation spring 524c has one end fixed to an upper portion of the X-axis fixation bar 524 and is able to downwardly urge the end portion 502a with another end brought into contact with an upper portion of the end portion 502a of the component feed tray 502.

It is to be noted that a magnet section 524b, which is one example of the magnetic material, is also built in the X-axis fixation bar 524 similarly to the X-axis fixation bar 514, so that the bar can be magnetically fixed in an arbitrary position on the tray placement surface 504.

By using the X-axis fixation bar 524 and a Y-axis fixation bar that has a similar structure, a placement position of the component feed tray 502 can be fixed in a horizontal direction and a vertical direction. Moreover, by forming the vertical direction fixation spring 524c so that an urging force of the vertical direction fixation spring 524c becomes able to have a magnitude capable of resisting a suction force of a suction nozzle, it is possible to resist the suction force and prevent uplift of the component feed tray 502 even when the component feed tray 502 is sucked and held by an erroneous suction of the suction nozzle. Although there has been described a case where an urging member is the vertical direction fixation spring 524c, it is also acceptable to employ an elastic

member other than the spring in place of the above-mentioned case so long as the member can secure an urging function.

Next, a schematic sectional view of an X-axis fixation bar 534, which is one example of a fixation bar according to a second modification example of the present second embodiment, is shown in Fig. 18. As shown in Fig. 18, the X-axis fixation bar 534 is provided with a plurality of vertical direction fixation surfaces 534c, which serves as one example of a second direction fixation portion and as one example of a second direction fixation surface to fix a placement position of the component feed tray 502 in the direction perpendicular to the tray placement surface 504 by being brought into contact with the end portion 502a of the component feed tray 502. The vertical direction fixation surfaces 534c are formed at mutually different heights roughly parallel to the tray placement surface 504 and are able to come into contact with the end portion 502a of component feed trays 502 that have heights coinciding with respective formation heights. Further, the X-axis fixation bar 534 is provided with a plurality of horizontal direction fixation surfaces 534a, which serve as one example of a first direction fixation portion and one example of a first direction fixation surface formed so as to individually correspond to

respective vertical direction fixation surfaces 534c and join the vertical direction fixation surfaces 534c that have mutually adjacent formation heights.

The horizontal direction fixation surfaces 534a are each formed so as to be roughly perpendicular to the tray placement surface 504 and able to fix a placement position of the component feed tray 502 to be brought into contact in a horizontal direction. As described above, the plurality of horizontal direction fixation surfaces 534a and the plurality of vertical direction fixation surfaces 534c are formed on the X-axis fixation bar 534, by which a plurality of step portions are formed of mutually corresponding horizontal direction fixation surfaces 534a and vertical direction fixation surfaces 534c.

As shown in Fig. 18, a step portion conforming to a height of the end portion 502a of the component feed tray 502, i.e., a step portion conforming to a height position of contact with the end portion 502a is selected from among the plurality of step portions provided on the X-axis fixation bar 534, and this selected step portion is brought into contact with the end portion 502a. That is, the horizontal direction fixation surface 534a of the step portion is brought into contact with the end surface of the end portion 502a, while the vertical direction fixation surface 534c of the step portion is brought into contact

with the upper surface of the end portion 502a. As a result, the placement position of the component feed tray 502 can be fixed in the horizontal direction and the vertical direction.

In forming the step portions, the step portions are required to be formed so that areas of the horizontal direction fixation surfaces 534a and the vertical direction fixation surfaces 534c are able to achieve fixation. For example, it is preferable to form the step portions so that an area of each vertical direction fixation surface 534c can resist a force that tries to uplift the component feed tray 502 caused by erroneous suction of a suction nozzle.

Next, a schematic sectional view of an X-axis fixation bar 544, which is one example of a fixation bar according to a third modification example of the present second embodiment, is shown in Fig. 19. As shown in Fig. 19, the X-axis fixation bar 544 is provided with a horizontal direction fixation surface 544a, which serves as one example of a first direction fixation portion and as one example of a first direction fixation surface to fix a placement position of the component feed tray 502 in a direction along the tray placement surface 504 by being brought into contact with the end portion 502a of the component feed tray 502. Moreover, the X-axis fixation bar 544 is also provided with a vertical direction fixation

portion 534c, which serves as one example of a second direction fixation portion and as one example of a second direction fixation surface to fix a placement position of the component feed tray 502 in a direction perpendicular to the tray placement surface 504.

As shown in Fig. 19, the vertical direction fixation portion 534c can be adjusted so as to vary a fixation height position thereof. Therefore, a height position of the vertical direction fixation portion 534c can be adjusted in accordance with a height of the end portion 502a of the component feed tray 502 of which a placement position is fixed, and various types of component feed trays 502 can be fixed.

Moreover, in the present second embodiment, there has been described a case where both the X-axis fixation bars 514 and the Y-axis fixation bars 516 have built-in magnet sections and are able to be magnetically fixed on the tray placement surface 504. However, the present second embodiment is not limited to the above case but is allowed to adopt fixation structure of other fixation bars.

For example, as shown in a schematic plan view and a side view of tray plate 603 of Figs. 20A and 20B, it is acceptable to provide a plurality of slot portions 604a on the tray placement surface 604 of the tray plate 603 and allow fixation bars 614 and 616 to be releasably fixed by

use of screws or the like in arbitrary positions within a formation range of each of the slot portions 604a.

The above fixation structure is effective structure in that magnetic influence on the electronic components 501 can be prevented by nonuse of magnetic fixation structure when, for example, electronic components 501 that are apt to be easily damaged by magnetic influence, are arranged and accommodated in the component feed tray 502.

Moreover, there is a further advantage in that, even when a force, that tries to uplift the component feed tray 502 when a suction force of a suction nozzle is great and the component feed tray 502 is erroneously sucked by the suction nozzle, becomes greater than a magnetic force of the magnet section 514b or the like, a mechanical force of engagement of screws or the like with the slot portions 604a can resist this uplifting force, and uplift of the component feed tray 502 can reliably be prevented.

According to the second embodiment, the following various effects can be obtained.

First of all, the X-axis fixation bar 514 and the Y-axis fixation bar 516 are provided with, not only a function to fix the placement position of the component feed tray 502 placed on the tray placement surface 504 of the tray plate 503 in the direction (horizontal direction)

along the tray placement surface 504, but also a function to concurrently fix the placement position in the direction (vertical direction) perpendicular to the tray placement surface 504. With this arrangement, the component feed tray 502 can be fixed in the horizontal direction and the vertical direction. Therefore, even when the component feed tray 502 is erroneously sucked by a suction nozzle, occurrence of uplift of the component feed tray 502 can be prevented beforehand by virtue of fixation also in the vertical direction. Therefore, leap-up and occurrence of displacement of the electronic components 501 possibly occurring in accordance with uplift of component feed tray 502 can be prevented beforehand, and efficient component mounting can be achieved.

In concrete, for example, the X-axis fixation bar 514 (likewise in the case of the Y-axis fixation bar) is provided with the fixation surface 514a that has a surface inclined with respect to a plane perpendicular to the tray placement surface 504. With this arrangement, the placement position of the component feed tray 502, which is brought into contact with this fixation surface 514a, can be concurrently fixed not only in the horizontal direction but also in the vertical direction. That is, concurrent fixation can be achieved by the fixation surface 514a that is one inclined surface.

Moreover, by virtue of the fact that the fixation surface 514a is the inclined surface, there can be provided a fixation bar, which can cope with fixation of component feed trays 502 provided with end portions 502a having various configurations and has versatility.

Moreover, in a case where the inclination angle θ of the fixation surface 514a of the X-axis fixation bar 514 is gently inclined with respect to, for example, the plane perpendicular to the tray placement surface 504, the fixation bar can cope with fixation of component feed trays 502 of more various end configurations. Conversely, in a case where the surface is largely inclined with respect to the perpendicular plane, fixation in the vertical direction can more reliably be achieved. As described above, in a case where the surface is largely inclined, the bar can be very effective for fixation of a component feed tray 502 reduced in thickness. Therefore, by utilizing such a feature, an appropriate inclination angle θ can be set according to a configuration of the component feed tray 502, a fixation force and so on.

Moreover, when the X-axis fixation bars 524, 534 or 544 are provided with the vertical direction fixation spring 524c, or provided with the plurality of step portions formed of the plurality of horizontal direction fixation surfaces 534a and the plurality of vertical

direction fixation surfaces 534c, or provided with the vertical direction fixation surface 544c of which a formation height is variable and adjustable, the bar can cope with fixation of a component feed tray 502 that has various end configurations.

Moreover, by fixing the end portion 502a of the component feed tray 502 in the vertical direction by the X-axis fixation bar 514 or the like even when the component feed tray 502 is deformed and warped, the tray can be placed on the tray placement surface 504 in a state in which this warpage is corrected. Therefore, even in this case, it becomes possible to achieve stable pickup of electronic component 501 by a suction nozzle.

Moreover, by making the X-axis reference surface 510a of the X-axis reference member 510, and the Y-axis reference surface 512a of the Y-axis reference member 512, shown in Figs. 13A and 13B serve as inclined surfaces, prevention of uplift of the component feed tray 502 can be further assured.

(Third Embodiment)

The present invention is not limited to the aforementioned embodiments but allowed to be put into practice in various forms. For example, a method for picking up components from a component feed tray by an electronic component feeding method according to a third

embodiment of the present invention makes it possible to prevent occurrence of uplift of the component feed tray beforehand by correlating an elevation operation for component pickup of a suction nozzle in a components feeder with a suction start timing of a suction nozzle for achievement of appropriate timing.

Fig. 22 shows a schematic side view showing a construction of a component mounting head 560 provided with a suction nozzle 561 as one example of a component suction and holding member for performing suction and pickup of an electronic component as described above. It is to be noted that the component mounting head 560 is provided for a component mounting apparatus (not shown) in which mounting of electronic components onto a circuit board is performed and able to be moved in a direction along an upper surface of a machine base relatively to the circuit board, the component feed tray and the like arranged on the upper surface of the machine base of this component mounting apparatus. Moreover, by performing a movement operation, an electronic component picked up from the component feed tray can be moved to a place above the circuit board and mounted.

As shown in Fig. 22, the component mounting head 560 is provided with suction nozzle 561 that releasably sucks and holds electronic component 501, an elevation unit

562 that moves up or down this suction nozzle 561, and a vacuum suction unit 563 as one example of a suction unit for sucking and holding the electronic component 501 at the suction nozzle 561.

The suction nozzle 561 has its lower end provided with a suction section 561a that can suck and hold the electronic component 501 while being brought into contact with the electronic component 501. This suction section 561a is connected to the vacuum suction unit 563 via a connecting tube (or suction tube) 563a, and this connection allows the aforementioned suction and holding to be effected. A suction valve 563b, which is one example of a control valve that enables opening and closing control, is provided partway at this connecting tube 563a. This arrangement makes it possible to perform suction and holding of the electronic component 501 by a suction force generated at the suction section 561a by putting the suction valve 563b into an open state for achievement of a state in which the suction section 561a and the vacuum suction unit 563 communicate with each other via the connecting tube 563a, and to prevent generation of a suction force at the suction section 561a by putting the suction valve 563b into a closed state for achievement of a state in which the communication between the suction section 561a and the vacuum suction unit 563 via the

connecting tube 563a is interrupted.

For the elevation unit 562, there can be employed a mechanism provided with a ball screw shaft section and a nut section meshed with the shaft section. By rotating the ball screw shaft section by use of a drive motor, the nut section in this meshing engagement can be moved up or down. By this operation, the suction nozzle 561 fixed to the nut section can be moved up or down. An elevation drive amount of the suction nozzle 561 can be controlled by, for example, controlling a rotational drive amount of the drive motor, and a range of the elevation operation, i.e., an upper limit and a lower limit are electrically or mechanically regulated. Moreover, the elevation unit 562 is provided with a speed controller 562a, which controls a lifting speed (time) and a lowering speed (time) of the suction nozzle 561.

Moreover, as shown in Fig. 22, the component mounting head 560 is provided with a control unit 570, which is able to supervisorily control the elevation operation of the suction nozzle 561 by the elevation unit 562, a speed control operation by the speed controller 562a, a vacuum suction operation by the vacuum suction unit 563, and an opening/closing operation of the suction valve 563b, while correlating these operations. By controlling an operation timing of the elevation operation of the suction

nozzle 561, the vacuum suction operation by the vacuum suction unit 563 and the opening/closing operation of the suction valve 563b while correlating these operations by use of the control unit 570, the electronic component 501 can be picked up by suction and holding.

Fig. 22 shows a state in which the aforementioned movement relative to the component mounting head 560 of the aforementioned construction is performed, and the component mounting head 560 is located in a position above the component feed tray 502. It is to be noted that a plurality of electronic components 501 is arranged on the component feed tray 502 while being able to be picked up.

A method for performing suction and pickup of the electronic component 501 arranged in the component feed tray 502 by use of the suction nozzle 561 provided for the component mounting head 560 as described above will be described next. Figs. 23A, 23B and Fig. 23C show schematic explanatory views, which schematically explain an operation of the suction nozzle 561 during suction and pickup as described above. Figs. 21A through 21C show timing charts showing states of changes plotted on an identical time base (horizontal axis) with respect to a state of change of the opening/closing operation of the suction valve 563b during the suction and pickup (Fig. 21A), a state of change of a suction pressure for the suction and holding of the

electronic component 501 in the suction section 561a (Fig. 21B), and a state of change of a height position (height position of the suction section 561a) due to the elevation operation of the suction nozzle 561 (Fig. 21C), which are plotted on the vertical axis. It is to be noted that operations described below are executed while being supervisorily controlled through correlation by the control unit 570 provided for the component mounting head 560. In the timing chart of Fig. 21A, an operation of the suction valve 563b is indicated in either an open or closed state. In Fig. 21B, a magnitude of suction pressure (suction force) generated in the suction section 561a is indicated by a state P0 in which no suction force is generated (e.g., a state in which the pressure is zero), a component holding and suction pressure P1 that is a minimum suction pressure necessary for suction and holding of the electronic component 501 and a suction pressure P2 that is a pressure higher than the component holding and suction pressure P1 and for reliably stably performing suction and holding of the electronic component 501. In Fig. 21C, the height position of the suction section 561a of the suction nozzle 561 is indicated by an upper end height position H0 within its elevational operation range and a height position in which the electronic component 501 can be sucked and held (i.e., height position in which the suction section 561a is

brought into contact with the electronic component 501) H1. In Figs. 21A through 21C, remarkable time points of a pickup operation performed by the suction and holding are indicated by times T1 through T5.

As shown in Fig. 23A, positional alignment of one electronic component 501, from among a plurality of electronic components 501 arranged in the component feed tray 502 with the suction nozzle 561, is performed, and thereafter, a descent operation of the suction nozzle 561 positioned in upper end height position H0 is started at time T1. At this time T1, the suction valve 563b is in the closed state, and suction pressure still remains P0 in the suction section 561a.

Subsequently, when the suction nozzle 561 is lowered and the suction section 561a is positioned in height position H1 at time T2, the suction section 561a is brought into contact with an upper surface of the electronic component 501. This state is shown in Fig. 23B. In accordance with this contact, the suction valve 563b is opened, and consequently a rise in the suction pressure is started in the suction section 561a.

In due course, the suction pressure reaches the minimum component holding and suction pressure P1 necessary for sucking and holding the electronic component 501 at time T3, with which ascent of the suction nozzle 561 is

started. Consequently, the electronic component 501 is lifted and picked up from the component feed tray 502 while the upper surface of the electronic component 501, brought into contact with the suction section 561a, is sucked and held by the suction section 561a with the suction pressure. This state is shown in Fig. 23C. Further, rise in the suction pressure of the suction section 561a is subsequently continued, and the suction pressure reaches suction pressure P2 at which reliable suction and holding can be stably achieved at time T4.

Subsequently, the suction section 561a of the suction nozzle 561 is positioned in the upper end height position H0 with the electronic component 501 sucked and held at time T5, and the component mounting head 560 is moved to a place above a circuit board by the aforementioned relative movement, and mounting of the electronic component 501 is performed.

Moreover, the component holding and suction pressure P1 generated in the suction section 561a of the suction nozzle 561 should preferably be set not lower than, for example, a suction pressure capable of sucking and holding the electronic component 501 and lower than a suction pressure capable of sucking and holding and uplifting the component feed tray 502. By thus setting the suction pressure, the component feed tray 502 cannot be

uplifted even when the suction nozzle 561 sucks a portion where no electronic component 501 is arranged on the component feed tray 502. Therefore, occurrence of leap-up and so on of the electronic component 501 due to occurrence of uplift of the component feed tray 502 can be prevented beforehand.

Moreover, such component holding and suction pressure P1 can be determined to an optimum value according to states (size, configuration, weight, and the like) of the component feed tray 502 and the component 501. For example, in a case where a large-size component 501, that has a weight of 8 g and is placed on a component feed tray 502 that has a weight of about 100 to 300 g, is sucked and held, the component holding and suction pressure P1 can be set to about 0.9 kPa. With this pressure, a safety factor is at least tenfold, and suction and pickup of the component 501 can reliably be performed while preventing uplift of the component feed tray 502 due to erroneous suction.

Moreover, as shown in Figs. 21B and 21C, by starting a rise in the suction pressure by releasing the suction valve 563b at, for example, time T2 when the suction nozzle 561 is brought into contact with the electronic component 501 so that the suction pressure reaches the component holding and suction pressure P1

capable of sucking and holding the electronic component 501 at time T3 when ascent of the suction nozzle 561 brought into contact with the upper surface of the electronic component 501 is started, the electronic component 501 can reliably be sucked and held at time T3.

Moreover, this timing of starting the rise in the suction pressure can be determined in consideration of time needed for this pressure's starting rising to reach the component holding and suction pressure P1 capable of sucking and holding the electronic component 501. For example, by determining a start of rising the suction pressure in consideration of the time needed for the pressure's reaching the component holding and suction pressure P1 with reference to time T3 of the start of the ascent of the suction nozzle 561, a time for generation of needless suction pressure can be shortened, and energy saving can be achieved. Moreover, by generating no suction pressure when no suction pressure is needed or, for example, during a descent operation of the suction nozzle 561 or the like, influences exerted on members other than the electronic component 501 subjected to suction and holding due to generation of the suction pressure can be reduced. For example, erroneous suction of the component feed tray 502 and occurrence of erroneous suction, displacement and so on of other electronic components 501 by the suction

nozzle 561 can be prevented beforehand. A timing of starting rise in the suction pressure as described above should preferably be at, for example, a time point immediately before time T2 when the suction nozzle 561 and the electronic component 501 are brought into contact with each other, or after time T2, and a desired timing can be determined according to features of the component feed tray 502 and size, weight and so on of the component 501.

For example, assuming that time T1 is a reference time (zero seconds in time) in Figs. 21A through 21C, then time T2, time T3 and time T5 can be 210 seconds, 260 seconds and 530 seconds, respectively. It is possible to start a release operation of the suction valve 563b to start rising the suction pressure at a time point after a lapse of 210 seconds from time T1 while managing these times by the control unit 570. However, since a time lag might practically exist from a release operation start command to actual release of the suction valve 563b, it is also possible to advance, for example, a timing of starting the release operation of the suction valve 563b by the above-mentioned time lag to a time point after a lapse of 200 seconds from time T1. By determining a time point of each operation in consideration of the above-mentioned time lag, reliable suction and pickup of the electronic component 501 can be achieved.

Moreover, a time from a start of descent of the suction nozzle 561 (i.e., suction command from the control unit 570) at time T1 to a start of the rise in the suction pressure in the suction section 561a of the suction nozzle 561 can preparatorily be set by, for example, a timer or the like. By thus setting the above-mentioned time by use of a timer or the like, the time point (e.g., time T2 in Figs. 21A through 21C) of the start of rising the suction pressure can be adjusted so as to have a desired timing immediately before time T2 or within a range of time T2 to time T3.

Furthermore, a speed of the descent operation of the suction nozzle 561 from time T1 to time T2 (i.e., the time needed for the descent operation) can be set to a desired condition by adjusting a setting of the speed controller 562a. In this case, the descent speed and the time needed for the descent of the suction nozzle 561 can be adjusted so as to alleviate impact and vibrations due to, for example, the suction nozzle 561 brought into contact with the component 501. By setting the descent speed late particularly when a small-size light-weight component 501 is sucked and picked up, impact and vibrations can be alleviated, and occurrence of leap-up and so on of the components 501 can be prevented beforehand. Moreover, the descent speed and the time needed for the descent of the

suction nozzle 561 may also be adjusted similarly.

According to the third embodiment, the component holding and suction pressure P1 generated in the suction section 561a of the suction nozzle 561 is set not lower than a suction pressure capable of sucking and holding the electronic component 501 and lower than a suction pressure capable of sucking and holding and uplifting the component feed tray 502. With this arrangement, the component feed tray 502 is not uplifted even when the suction nozzle 561 sucks the component feed tray 502. Therefore, occurrence of leap-up of an accommodated electronic component 501 can be prevented beforehand.

Moreover, by determining the timing of starting applying the aforementioned suction pressure by an inverse operation with reference to the timing of starting the ascent of the suction nozzle 561 brought into contact with the upper surface of the electronic component 501, occurrence of influences on a periphery due to the start of applying the suction pressure or, for example, occurrence of an erroneous suction of the component feed tray 502, occurrence of erroneous suction of surrounding electronic components 501 and so on can be prevented beforehand while assuring achievement of reliable suction and holding of electronic component 501.

Therefore, reliable and stable suction and pickup

of the electronic component can be achieved, and this allows efficient component mounting to be achieved.

It is to be noted that effects possessed by the aforementioned various embodiments can be produced by properly combining arbitrary ones of the embodiments.

Although the present invention has been fully described in connection with the preferred embodiments thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications are apparent to those skilled in the art. Such changes and modifications are to be understood as included within the scope of the present invention as defined by the appended claims unless they depart therefrom.